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ARC LIGHTS.

IT is long since anything striking has been recorded relating to improvements in arc lamps, and the report that a new lamp has been devised, in which a hydro-carbon vapour, used in conjunction with the arc, gives twice the light for the same expenditure of electrical energy, will awaken, therefore, a certain degree of interest, if nothing else, in this mode of electric lighting. It is believed by the inventor and his friends that nothing less than a revolution in arc lamp illumination will be effected by the new device; but our opinion, which is subject to modification and reconsideration after seeing the apparatus tested, does not lead us to the same conclusion. We do not doubt that hydro-carbon vapour impinged upon the arc will increase the amount of light in much the same manner as does albo-carbon or napthaline when vaporised in a gas flame, but we question whether the advantage gained is commensurate with the trouble and extra expense involved in producing it, for what may seem simple enough in a laboratory experiment does not necessarily work out successfully in practice on a large scale. It seems that the method is by no means new, for we remember perfectly well experiments of a similar kind being carried out in the works of Messrs. Latimer Clark, Muirhead & Co., as long ago as the year 1879. A hollow lower carbon was employed, and ordinary coal-gas and various hydro-carbon vapours introduced into the arc. Unfortunately we cannot remember on whose behalf the experiments were undertaken, but possibly Profs. Ayrton and Perry, who were then daily at the works, Dr. Alex. Muirhead, or Mr. Graham, the then foreman of the factory, may be able to enlighten us.

But without further intruding our own opinion upon the use of hydro-carbons in arc lighting, we feel it incumbent upon us to say that the tests brought forward to show the advantages of the hydro-carbon method may, in reality, deceive both the inventor, his friends, and possibly Dr. Hopkinson himself, who has compared the apparatus with an ordinary lamp and given a report thereon, which we have perused.

Probably no source of artificial illumination is so fitful as that from arc lamps when a number are burning in series, but this remark, of course, does not apply with full force to the experiments of Dr. Hopkinson, although we imagine that both lamps were supplied in series with electrical energy from the same dynamo or accumulators. If this happened to be so, whether the regulation is manual or automatic, the slightest difference made in one must affect the other, favourably or the reverse, as the case may be.

It is pretty evident from Dr. Hopkinson's electrical constants, that although the ordinary lamp had the advantage in consuming slightly more electrical energy, yet the new one had the longest arc, and in this simple fact may perhaps be disclosed its apparent great superiority in illuminating power. Placed at an angle of 45° with the horizontal, there is little reason to doubt that the crater, from whence the bulk of the light proceeds, was more exposed or open in the new lamp than in the ordinary one, and it seems a great pity that Dr. Hopkinson did not take a second series of tests with the respective positions of the lamps reversed. It is highly probable that the differences in illuminating power would then have been less noticeable, although the hydro-carbon arrangement might still have given the best result. It would have been useful data had the lengths of arcs, the sizes of carbons, and the resistances of each been added, for probably the hollow electrode, with its lower conductivity, may have something to answer for. It would have also been interesting to students of photometry to know the distances of each lamp from the photometer. That he found some observations unfavourable to the new lamp, is in itself enough to make one dubious as to the advantages claimed for it, but to pit two powerful sources of light against each other in probably a confined space, does not seem to us to be the best method of obtaining accurate readings of the real illuminating power of each, and, altogether, the

report does not, in our opinion, do justice to either the claims for the new device or to the merits of the old.

The electrical world would gladly hail an invention by which the cost of light production could be reduced by one half, and we shall be pleased to hear further particulars of this lamp in actual practice. It is at all times difficult to decree the ultimate fate of an invention on the strength of mere experimental trials, but with the facts before us we scarcely think that this one is destined to bear out the somewhat extravagant claims made for it.

Moreover, the contention that by this invention electric arc lighting can be produced equivalent to that of gas at one shilling per 1,000 cubic feet, shows that the inventor and his friends cannot be aware of the progress made of late in this domain of electric lighting, for even with our present available plant the cost is no more than that above quoted.

The Electric Light Done For.

THE United States are always announcing marvellous inventions. One of the latest is a new light devised by Mr. W. J. Norton, of Pittsburgh, which is going to knock the electric light on the head. A 500 C.P. light is to be supplied at one cent per hour, and a highly intelligible account is given of what it is. The light in question, we are told, is "essentially a chemical discovery rather than a mechanical idea and consists of a peculiar tape that is fed by a simple clockwork. While it is peculiarly adapted to street or other stationary purposes of illuminations (*sic*), yet it is also applicable to portable or hand lamps; and in point of intensity it is not surpassed by electricity, its light is much softer and far easier to the eyes. It feeds itself, requires neither pipes, wires, or other connections, and in size may be produced for 300 to 7,000 C.P. It is absolutely non-explosive, emits no smoke or objectionable vapour, is applicable to any purpose, and can be handled with as equal safety by a child as by an adult." After perusing this fine specimen of "American as she is wrote," we have no doubt that electrical engineers will come to the conclusion that the sooner they shut up shop the better.

Medico-Electric Belts.

THE puff on this class of goods has, as a rule, been confined to papers which are completely ignorant of the subject they deal with, and it is with regret that we notice a journal, professedly technical, going out of its way to give illustrated notices of such appliances. In describing ————'s medico-electric belt, we read that it has been aptly remarked that "————'s patent portable battery constitutes a complete family doctor in itself." This is interesting news. We may now expect that when a lady finds herself as Howe expresses it in "Douglas," as "Women wish to be who love their lords," the services of the family doctor will not be requisitioned, but a ————'s portable battery obtained instead.

Fatalities from Electric Light Wires.

THE article which we publish on another page from a valued correspondent does not shed any fresh light upon the facts already reported from America Nobody, in this country at all events, ever suggested that 400 lives had been lost, and the exact number, so far as could be ascertained previous to Christmas last, was chronicled in the pages of the REVIEW. We believe that at the present moment the deaths fall just short of 100.

Professional Etiquette.

THE Brighton electric lighting scheme is still the theme of some rather acrimonious correspondence in the columns of the *Sussex Daily News* between Alderman Hallett and Mr. Killingworth Hedges. Of this we should have taken no notice but for the following extract from a letter sent to the Brighton journal, and which appeared in last Monday's issue :—

> With regard to the paragraph which you quote from the ELECTRICAL REVIEW, as I am informed that the insinuation emanated either directly or indirectly from Alderman Hallett, its pertinence is lost, and the utter collapse of the Alderman's scheme can be the only excuse of such ungentlemanly "ink-slinging."
>
> Yours, &c.,
>
> KILLINGWORTH HEDGES,
> *Member Institute Civil Engineers,*
> *Member Institute Electrical Engineers.*

We have already expressed ourselves in somewhat strong terms concerning the peculiar manner in which the name of Mr. Hedges became associated with this matter, and we will now ask the distinguished engineer, who so readily detects the difference between gentlemanly conduct and the reverse, why he has chosen to make a reference to the REVIEW on mere idle rumour, that is if the so-called information was not evolved from his own inner consciousness without any outside assistance whatever. So that he should no longer labour under a misapprehension which we feel so acutely, we hasten to say that we have not the pleasure of Alderman Hallett's acquaintance, neither has that estimable gentleman been in correspondence with us, and the paragraph quoted was written by us after a perusal of Mr. Hallett's published reply to Killingworth Hedges's attack upon Mr. Shoolbred's estimate. Now perhaps he will favour us with the name of the informant who seems to know so well from whence the Editors of the REVIEW derive their inspiration when they find it necessary or deem it a duty to protest against unprofessional practices? We would also warn him in quite a friendly way that it is not altogether politic to make insinuations in a newspaper which cannot be substantiated.

A Little Knowledge, &c.

MR. HUTCHINSON, in his presidential address to the Institution of Manchester Gas Engineers, makes several bold assertions in regard to electric light which require a little editing if not contradiction. He quotes as an authority on the subject of the injurious effects of the incandescent light to the eyes, M. Lubinsky, who, at a congress of Russian physicians, dwelt upon cases, brought under his notice, of eye affection produced by the electric light. Mr. Hutchinson, we think, will find that the Russian physician speaks of arc lights only, and these in rare cases. Then Mr. Hissey's statement in the *Standard*, pointing out that electric light would cause water colours to fade, was flatly contradicted by the experiments of another correspondent. The president further states "As to deaths, fires, &c., caused

by electricity, the matter is before you every day in the Press, and a dreadful record it is." When any person utters such a statement as that it must, in the opinion of reasonable men, render him totally unfitted to arrive at any sound judgment respecting the merits, or demerits, of the electric light. Gas still beats the record.

The Electrical Trades Section.

THE organ of the London Chamber of Commerce calmly surveys the work done by the Electrical Trades Section during the year which has passed. It speaks triumphantly of a meeting held by a forlorn committee for the purpose of whispering treason against an over-fed local board; and how, by a unanimous vote of one, it conveyed resolutions to the Board of Trade with regard to licences and provisional orders. Verily, we believe, if this body commanded the sun to stand still, it would'nt. It forbade the electrical industry to take part in the Edinburgh Exhibition, and it did; a few hundred circulars were issued to the trade about a matter on which it received one reply, which letter should be placed in a gilt frame as a standing monument for future generations to see how their forefathers twaddled. There was one important resolution carried without dissension at each meeting, which our contemporary omitted, and that was the motion which sanctioned the presence of a deaf reporter and a small boy, who, along with a number of empty chairs, generally filled the room. This section has missed its vocation. However, apart from all light heartedness, we are sorry not to see the electrical portion of the London Chamber of Commerce grappling with the difficulties that beset the industry in a more courageous manner. It has a perfect right to be heard, and could make a position of influence, respected and appealed to on many of the great questions which perplex the members of the electrical trades. Henceforth we trust it will not be afraid of tackling subjects upon which it might effect some good.

Meteorological Observatories.

IT is stated that the Japanese Government is about to establish a meteorological observatory in the Lin-Chin Islands, a position of some considerable importance, more especially with regard to observations in the course of the typhoons which are encountered in the China Seas. A great deal remains to be done in the direction of establishing observing stations throughout the region subject to these storms, and in order that the observations made may be of practical use to shipping, it is absolutely necessary that a more complete system of telegraphic communication should be effected. For some time the Japanese Government has had under consideration the connecting of the Lin-Chin group, by means of a submarine cable, with Japan. The establishment of the observatory on the islands in question may prove an additional stimulus to this long delayed enterprise. In this connection we notice that the Spanish Government has in hand the organising of a complete system of observatories along the coasts of Cuba and Puerto Rico. The storm warnings issued from those stations actually existing have already proved of great service to the not inconsiderable commerce carried on in the Gulf of Mexico, the Florida Straits and the the seas more immediate to islands mentioned.

The India-Rubber Monopoly.

AS already announced, the Brazilian Central Government has cancelled the concession granted by the Para Local Government to the Companhia Mercantil. When it is considered that the trade in rubber alone between Great Britain and Para is estimated at nearly two millions sterling yearly, and it was probable that similar monopolies would be granted in respect to coffee, tobacco and other Brazilian produce in which British commerce is so largely interested, the authority of the Central Government was wisely exercised in restraining the too independent action of a local body.

"A Slave Dealer of 1690."

THE *Cornhill Magazine*, for March, contains a most interesting article under the above heading. It deals with the conditions of trade, and customs and manners existing on the Gold Coast at the period mentioned. More especial interest is perhaps attached to the article in question in view of the present relations between the French and the Kingdom of Dahomey. It is not difficult to divine, for the article is unsigned, that the writer is also the author of two very entertaining volumes, respectively entitled "On a Surf Bound Coast," and "Glimpses of Feverland," descriptive of experiences on the West Coast of Africa during two successive cable expeditions. It may be very justly urged that the article under notice is scarcely of a nature to warrant its introduction to the columns of a purely technical publication, but our object in stepping beyond the limits of our legitimate sphere is to point out, taking as an example the article and the volumes mentioned, the wide field and rich material so frequently offered in cable expeditions to anyone possessed of a facile pen and ready observation. It is to be sincerely regretted that such advantageous opportunities for disseminating information of so varied and instructive a character should have been so very seldom taken.

Arc Lamp Counter Electromotive Force.

"THE great lesson to be derived from a knowledge of this effect," say Messrs. Slingo and Brooker in their new work on electrical engineering, "is that the E.M.F. of the current which is passed through the lamp must always exceed 39 volts, or it will fail to maintain the arc." In connection with this phenomenon it will be found interesting to peruse the first paragraph on page 280, where the performances of alternating *versus* continuous current arc lamps are criticised by the Frankfort Commission.

Rip Van Winkle.

THE New York *Electrical Review* is years behind the times. In its last issue it gravely states that a highly interesting fact has just been brought to light by Mr. Terrill of that city. Imagine our feelings when the discovery turns out to be that illuminating gas when used to drive a gas engine and dynamo, produces a greater amount of light by transformation into electrical energy than when consumed direct in the ordinary jets. This result was common knowledge ten years ago, and we can therefore only imagine that the editor of our contemporary has been playing Rip Van Winkle.

THE INTRODUCTION OF THE ELECTRIC LIGHT IN FRANKFORT-ON-THE-MAIN.

[FROM A CORRESPONDENT.]

(*Continued from page* 253.)

THIS inferior performance of the alternating current arc lamps is compensated in their use for illuminating shops, halls and streets, by the circumstance that they require a considerably lower tension—less by 20—30 per cent.—than do continuous current arc lamps. Thus, the alternating lamp used to light one of the shops required a tension of 32—35 volts between its carbons, whilst the Schuckert continuous lamp, acting with the same consumption of energy, required a tension of 43—44 volts between the carbons. Hence, in an installation with a tension of 105 volts, which permits the insertion in series of only two continuous current arc lamps, three alternating current arc lamps may be inserted in series and may work up to 8 ampères.

The frequent change in the direction of the current occasions, in the alternating lamps, a vibration which produces a gentle, and not *per se* annoying, humming. This humming in a lamp carelessly constructed or badly managed may become a disturbing noise. According to our experience this noise may be prevented if the lamps are of suitable construction and are kept in good order.

Our sittings were held in a room of a wooden laboratory erected by the Board of Works, and lighted by one of the alternating current arc lamps under examination. How very trifling was this humming of the lamp appears from the fact that, in spite of the great resonance of the wooden sides and ceiling of the room, no annoyance or disturbance was experienced during our deliberations, and that to perceive it general silence had to be observed for a time. Once only the lamp occasioned a disturbing noise, *i.e.*, when a part of the regulating mechanism got loose and acted imperfectly. After the removal of this irregularity the noise subsided again into the ordinary faint humming.

This property of the alternating lamp does not, in our judgment, present any reason for excluding its use, the more so as arc lamps, whether fed by continuous or alternating currents, sometimes emit a hissing noise; and further, there exists a series of types of continuous current arc lamps which produce loud rattling noises by their regulating machinery.

As regards the consumption of carbons in the two kinds of lamps the alternating current lamp requires about 20 per cent. more than the continuous lamps. But as the expenditure in carbons amounts only to about 10 per cent. of the total working cost (assuming lamps of the customary strength of 6 to 12 ampères), this larger consumption of carbons does not raise the cost of the alternating arc light by more than 2 per cent., as compared with the continuous arc light.

Supposing 100 watts energy is supplied at 8 or at 6 *pfennig* per hour, the cost of the two kinds of lamps will be for the small lamps :—

Continuous current	...	$32\frac{1}{2}$ or 26 pf.
Alternating „	...	$33\frac{1}{2}$ or 27 pf.

According as 8 or 6 ampères are used.

For the larger lamps :—

Continuous	... ...	61 or 48 pf.
Alternating	... ...	62 or 49 pf.

For the production of equal quantities of light according to the method of introducing the alternating arc lamps, their hourly cost would be raised by 25 per cent., and consequently the small lights would come to between 34 and 42 pf. or 27 and 34, and for the large lamps between 62 and 78, or between 49 and 61 pf.

The rapid periodic change of the direction and strength of the alternating current involves as many rapid changes of the strength of the alternating arc light. These changes are not perceived in the lamp itself, or in objects at rest or in slow motion. But in objects in rapid movement they appear manifold. Glow lights fed with an alternating current do not produce this peculiarity.

Question V.

What is the respective position of the alternating and the continuous systems as regards the applicability of electric meters, with especial reference to size, cost, simplicity, trustworthiness, accuracy, and sensitiveness for a consumption of current which varies between wide limits, as well as in durability ?

The electricity meters (Blathy's system) laid before us prove that, within the limits of the strength of current occuring in practice, they work with an accuracy within 3 per cent., and that in simplicity, trustworthiness, size, cost, and sensitiveness, they fulfil all reasonable demands.

As regards the application of meters, the alternating system is in no manner inferior to the continuous system.

Question VI.—Continuous Current Transformers.

(*a*) Can a useful and convenient continuous current transformer be considered to exist ? Has its efficiency been proved by experience, or can it be demonstrated in any other manner ?

(*b*) How does it compare with the alternating current transformer in respect to cost of fitting up and working, size, degree of efficiency with different loads, trustworthiness, safety, capability of regulation and attendance, &c. ?

Continuous current transformers which have found extended use in lighting cities have not come to our knowledge.

Continuous current transformers in which both coils (primary and secondary) are arranged on one and the same armature, as it was provided in Schuckert's earlier proposal, and, as it is projected in a more recent offer of Herr Lahmeyer, cannot be recommended on account of uncertainty in working, although they promise a somewhat higher efficiency than the transformers proposed by Schuckert & Co., in which the primary and the secondary coils are arranged on two separate rings. There is no apparent reason for assuming that a continuous current transformer of the latter construction would not hold good as regards safety of action and trustworthiness. To our regret we have had, during our experiments, no opportunity of seeing and testing a transformer of this kind. As no project for Frankfort has been laid before us which seeks to employ continuous current transformers in the same manner as the alternating system proposes to apply the alternating current transformers, a direct comparison of the first cost and the working outlay of the two systems is out of the question. The application of the proposed continuous current transformers is to be combined with an installation of accumulators. Hence the working costs required can neither be separated nor compared at once with the working costs of the alternating current transformers.

It must further be remarked that the continuous current transformers—unlike the alternating transformers, the operation of which does not involve the movement of masses—necessitates rapidly rotating masses, and has hence to be set up like a dynamo in especially constructed rooms, where it requires continued attention. The new Schuckert plan requires nine such subordinate stations distributed over the city for the installation and management of the transformers. In the alternating current installation, as proposed, there will be 150 groups of alternating transformers to be placed in those quarters of the city to be supplied with electric light, and requiring no attendance of this kind but merely a periodical inspection.

The degree of efficiency of 82 per cent. claimed by the firm Schuckert and Co. in their prospectus can, in our opinion, be attained with a normal load of their continuous transformer bordering on the upper limit of its capacity. This degree of efficiency represents a loss

of 18 per cent. as against the loss of 5 to 6 per cent. in the alternating current transformer.

As to the certainty of the work Schuckert's plan contemplates a reserve transformer at each of the nine subordinate stations.

Question VII.

Is there an accumulator which can be recommended for general use on the large scale in an extensive municipal installation, regard being had to price, trustworthiness, duration, degree of efficiency, size, simplicity of management, &c. ?

On this question the views of the Commissioners were extremely conflicting. Prof. Ferraris considered accumulators as untrustworthy. Prof. Weber thought that the city of Frankfort would incur no danger if the firms supplying accumulators were under contract at once to remove any defects. At the same time he considered that there is as yet no evidence as to the durability of the new Tudor accumulator. Director Uppenborn thought the Tudor accumulators admissible. Prof. Kittler inclined to the same opinion, and the municipal architect, Lindley, declined to express an opinion.

Question VIII.—The Five-Lead System.

(*a*) Is the five-lead system suitable ? Has it held its own anywhere ?

(*b*) What is its character as to simplicity, capability of regulation, trustworthiness, and certainty in working ?

The earlier proposal of the firm Siemens and Halske as sent in with accompanying plans, offering to supply the city of Frankfort with electric currents by means of the "five-lead system," cannot be regarded as to the purpose.

The present project of the same firm is very different, and has been freed from a number of the defects of the former proposal.

A five-lead system of this form has hitherto not been brought into action anywhere.

The arrangement of the machinery in the new project has been rendered as simple as in the two-lead system by the elimination of the intermediate machines.

The main supplying cables can be brought into action as two leads by the introduction of special regulating stations in the several parts of the difference to be supplied.

Concerning the mode of regulating the current in the conductive net, Siemens and Halske lay down two alternative projects. According to the statements of their representatives they give the preference to the second alternative, which depends on the use of small regulating dynamos. These effect a suitable equalisation in the consumption of current between the different sections of the cable of the five-lead system with a loss of about 5 per cent. of energy, approximately equal to that in the alternating current transformers. These small dynamos would be placed at about nine points of the district in small kiosks in open places. As they contain parts revolving at the rate of 2,000 turns per minute, they need regular superintendence and care in oiling and attention to the journals.

The tension employed in this system would be about 440 volts in the conductive net and 500 at the central station. This tension necessitates the greatest care both in the distribution of the house leads, and in the construction of all parts of the installation and its accessories accessible to the consumers, so as to obviate any unpleasant and hurtful effects of the tension, which in the most unfavourable cases may rise to 440–470 volts.

The working of the "five lead" system requires a careful distribution of the points of consumption over the four separate divisions of the system.

A disadvantage of the system lies in the feature that the distribution leads on each side of the streets consist of five separate cables. The proposal conveyed in the explanations to unite these five leads in one or in two cables seems to us not to be recommended under any circumstances. As, further, in order to effect a quite equable distribution of the points of consumption over the four sections of the system, the several house-leads have, in most cases, to be connected to all the five cables, the work of connecting becomes more complicated, and the expense considerably higher than in the other systems.

As a matter of course, the multiplication of cables and of points of junction must increase the possibility of accidents and damage.

All these objections, however, are not of such weight as to exclude the five-lead system from use where its application may seem advantageous on other grounds.

Question IX.—Supply of Current for Electro-Chemical Purposes.

(*a*) What importance is to be ascribed to the supply of electric current in a municipal installation for electro-chemical uses ?

(*b*) Under what conditions, and by what means, would it be possible to meet this demand in the different systems proposed ?

In all the municipal central installations hitherto carried out, the consumption of current for electro-chemical purposes has been only a vanishing fraction of the whole.

Where large electro-chemical works require great quantities of electricity, it will always be cheaper to produce the current in the works than to obtain it from a municipal installation. (?)

The supply of current for electro-chemical purposes will be of subordinate importance in Frankfort, which is more a residential than an industrial locality. In almost all electro-chemical work a strong current of low tension is needed. Hence, whatever system is used for working the central, it will rarely be possible to derive from it directly the current needed for electro-chemical processes. Special machines must be used to transform the current into the state required for electro-chemical workshops.

(*To be continued.*)

THE CUTTRISS DENTAL MOTOR.

THE Cuttriss dental motor is a great improvement upon the usual types of these machines, more especially from the fact that the burr can be stopped instantaneously,

FIG. 1.

the momentum of the armature having no effect upon it. Fig. 1 shows the complete arrangement on a stand (shown broken, for economising space), of suitable height carrying a swivelling bracket upon which the small motor is pivotted, and can be turned to any desired point ; the electric current is led to the terminals shown on the base of the pedestal and so up

to the motor, the armature is thus caused to revolve and drive the shaft and flexible connection to the burr. Fig 2 shows an enlarged view of the machine, it will be seen that the field magnets are bent in the form of an arc, and are provided with pole pieces which embrace the armature at the sides, the armature itself is of the Gramme ring form and wound in four parts the motor shaft is carried in bearings supported on star-shaped brackets from the field magnet cores. The mechanism for obtaining an instantaneous arrest of the burr deserves special attention, and is shown in fig. 2 and more clearly

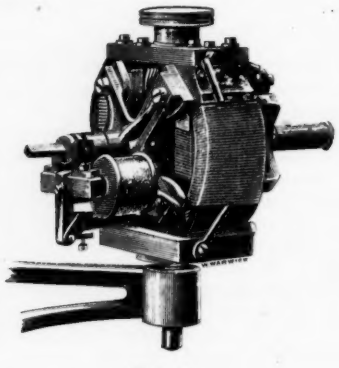


FIG. 2.

in fig. 3. The armature is mounted upon the hollow shaft, B, which runs in the bearings spoken of above, this shaft carries one-half of a clutch, C. Inside the shaft, B, a shaft, A, is free to revolve and is squared at the end, D, for some distance. Upon this square part the half clutch, E, can slide. A bobbin, G, is fixed in a suitable position upon the framework of the machine, and is placed in series with the armature of the machine; it therefore becomes an electro-magnet directly the current is switched on and attracts the armature, J, which is carried by the bell crank lever, H, moving on

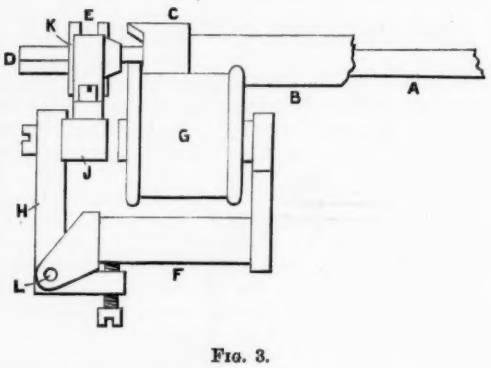


FIG. 3.

the fulcrum, L, this moves the fork, K, throwing the clutch, E, into gear with C, and so causes the shaft, A, to revolve. A spiral spring is so placed in F as to keep the armature normally free of the electro-magnet, G. It will thus be seen that as soon as the current is switched off, the clutch E, falls out of gear with C, and the drill stops instantaneously, although the shaft, B, may continue to revolve for some time, owing to the acquired momentum of the armature. A further advantage of the clutch is that any ordinary hand piece and flexible shaft can be easily attached to the motor without any special fitting. The motor is reversible. An adjustable resistance coil is arranged at the base of the pedestal and controlled by the foot so that the motor can be started, stopped and regulated in speed at pleasure without the operator moving from his working position.

The machine is made and patented by Messrs. Cuttriss & Co., and is very light and compact.

BARRACLOUGH'S PATENT WIRE COVERING MACHINE.

AMONG the recent improvements made in machinery for insulating and covering electric wires and strands, Barraclough's patent wire covering machine, which we illustrate above, shows a considerable advance in the process of covering wires with cotton and other fibrous yarns.

The great desideratum in this branch of manufacture is to obtain a perfectly even covering—the wires must show no inequalities, no thin or thick places—and in order to effect this, the yarns used must be of good quality and even spinning, and the application of the yarns to the wires must be faultless.

Considerable difficulty is experienced in arriving at a perfectly even covering, by reason of the breakages of the yarns, the carelessness and want of skill of the operator, and also by defective machinery.

The covering heads revolve at a very high speed, and the yarns are liable to break, the bobbins frequently become empty, causing inequalities in the covering, more especially when the attendant fails to observe the breakage or failure of the yarn. The machine has therefore to be frequently stopped, the broken yarn or yarns pieced up and fresh bobbins inserted in the flyers. During this operation the whole machine is standing still, necessarily involving great loss of production.

The object of this invention is twofold :—

1. The construction of wire covering machines in such a manner that each covering head can be worked and stopped quite independently of the others; thus, if from any cause one head is stopped, the others are not affected but continue their work at full speed.

2. The application of an automatic stopping apparatus to each flyer, so that as soon as a thread breaks, or a bobbin becomes empty, the head stops automatically and instantaneously, thus preventing imperfect work and enabling the operative to see at a glance which head needs attention.

These machines are usually made with six heads to cover six wires simultaneously, and each head has two flyers with automatical stop motion, arranged to run in opposite directions so as to apply two coverings to the wire, right and left hand.

These heads are quite independent of each other and can be stopped and started at will.

The following description of one head of the machine will render the mechanism clear to our readers.

On the driving shaft, J, which extends along the machine, a number of discs, M, are keyed, there being one to each head. Adjoining each disc, and to a certain extent covering it, is a grooved pulley, N. One side of this disc is hollowed and has a circular leather plate fixed on it, which acts as a frictional surface by which the grooved pulley, N, is driven, when pressed up to the disc, M. Over the pulley an endless band, K, is passed, which drives the two rotating covering flyers, B and C, in opposite directions. The grooved pulley can be slid upon the shaft by means of a lever, by moving which to the left, contact of the frictional surfaces is established or *vice versa*. The wire is drawn from the reels, A—shown in place at the upper part of the machine in fig. 1—and is passed through the hollow spindles of the covering head, after which it follows the course shown until it reaches the draw roller, E, around which it is taken several turns. The rate of rotation of the draw roller regulates the speed of covering, and the reels, G, upon which the covered wire is wrapped, are driven by a band from the shaft on which the draw roller is fixed, so that the speeds of the two are relatively proportionate. The covering material is carried in spools fixed upon pins fastened in the face of the covering flyers, L.

Instead of driving the draw roller shaft, O, by bevel gearing, it is driven by a worm and worm wheel, the former being fixed on the driving shaft. In this way a

regular speed of draw through is obtained, entirely free from the irregularities arising from back lash when ordinary gear wheels are used. This is of the utmost importance to ensure perfectly even covering.

The stop motion consists of a small finger, U, attached to the covering flyer in such a way that as the latter is rotated the finger tends to assume a perpendicular position. It carries an eye through which the yarn is passed, the tension upon the latter being sufficient to prevent the finger from taking the position named.

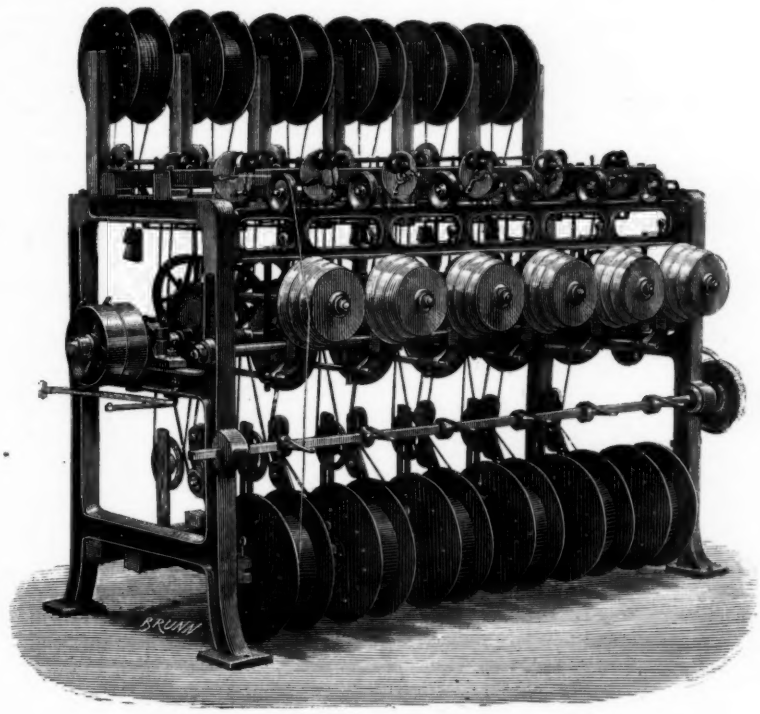


FIG. 1.—GENERAL VIEW.

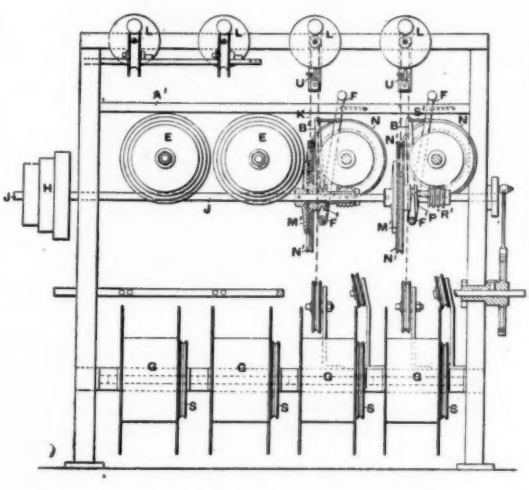


FIG 2.—FRONT ELEVATION.

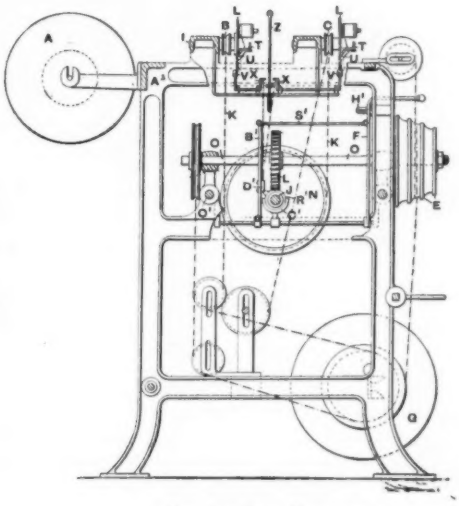


FIG. 3.—END ELEVATION.

As soon as a yarn breaks, the finger assumes the perpendicular, and in its rotation strikes one end of a small lever, V, which is oscillated through an arc of 90°. The movement communicated to the small lever, V, causes a small mechanism, X, to descend and press a weight, D, which is suspended by a cord in the slot of a large lever, B. On the latter is a projection, in front of which the weight is forced, and is thus brought into the path of a cam on the driving shaft. In this way the lever is pressed back, and by means of a connecting rod, S^1, it raises and releases a small lever, F^1, so that it can be drawn over by a spring, and the section is thus stopped in the manner previously described. To restart the machine it is necessary to piece up the thread and restore the levers, V, X, to their original positions. This is done by a small lifting rod, Z, specially provided and arranged to act for both discs.

The machine has met with considerable success, supplying, as it does, a long felt want; the manufacturer is rendered in a large measure independent of highly skilled labour, whilst the production is relatively much higher than that of other machines, because when one head is stopped the other heads are unaffected thereby. Therefore perfect covering, large production, small cost, are attained by the use of this machine.

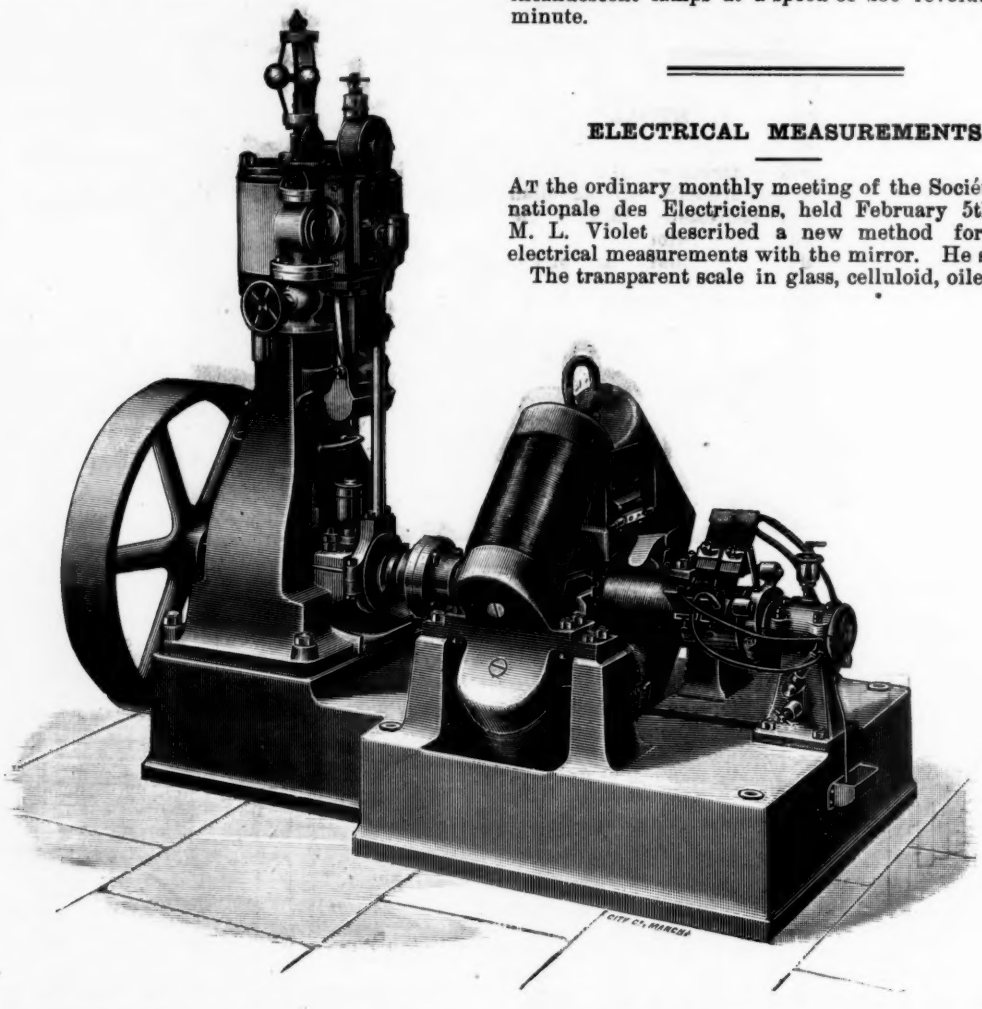
An additional advantage connected with this machine consists in the wide range of thicknesses of wire which can be covered. The machine is made by Messrs. Thos. Barraclough & Company.

"TYNE" COMBINED ENGINE AND DYNAMO.

THE illustration represents a combined plant suitable for ship lighting, or places where space is limited, which has recently been designed by Mr. W. C. Mountain, and is now being made in all sizes by Messrs. Ernest Scott & Co.

It will be noted that there are many important advantages of this arrangement, the chief being extreme simplicity, stability and accessibility.

The engine illustrated is of the vertical type, the crankshaft running in oil. By adopting this method of lubrication the engine is capable of running continuously without attention, as the splash of the crankshaft not only lubricates itself and the crankshaft bearings but also the guide bars and crosshead. In addition, however, to this means of lubrication, oil boxes are provided for all moving parts.



The engine is fitted with a Pickering governor and equilibrium throttle valve and it is found in practice that this governor is capable of regulating the engine perfectly under great variations of load.

The dynamo is of Messrs. Ernest Scott & Company's standard pattern, but it will be observed that the bedplate is extended to form the foundation for the engine. In making the original design for the "Tyne" dynamo one of the chief features borne in mind by the manufacturers, was to have a massive and substantial bedplate, and it was so designed that should it be at any time desired to make a coupled plant the additional length of bed could be cast on without any alterations to the standard dynamo bedplate pattern.

The plant illustrated has just been fitted by Messrs. E. Scott & Co. in two large steamers for the frozen meat trade, each combined plant being capable of giving an output of 100 amperes at an E.M.F. of 65 volts, the speed being 300 revolutions per minute and it is found in practice that both the engine and dynamo run perfectly satisfactorily at this speed and require practically no attention. The firm is making a speciality of combined plants similar to the engraving, their standard sizes being for 30, 50, 75, 100, 150, 200 and 250 incandescent lamps of 16 C.P. each, the speeds varying from 400 to 250 revolutions per minute, according to the output of the dynamo. A similar plant is now in hand for lighting a large cold meat store in the Argentine Republic, and capable of running 250 16-C.P. incandescent lamps at a speed of 250 revolutions per minute.

ELECTRICAL MEASUREMENTS.

AT the ordinary monthly meeting of the Société Internationale des Electriciens, held February 5th, 1890, M. L. Violet described a new method for taking electrical measurements with the mirror. He said :—

The transparent scale in glass, celluloid, oiled paper, has contributed largely to the spread which has taken place in recent years of the use of galvanometers and of electrometers with the mirror; it is easy to manipulate, and may be used in daylight operations; this was an impossibility when we had only the old method of scales and petroleum lamps combined.

Still cases do occur in which one hesitates to use the mirror, and has recourse to galvanometers with movable needle and dial. Now it is to be noted that a needle is rarely 0 m., 10 long, and that scales are, as a rule, situated at 1 m. from the mirror, so that the exactness of the reading by the dial is always 20 times less at the least.

The mirror is frequently discarded in connection with industrial matters for the following reasons :—

In the first place the two parts, the galvanometer

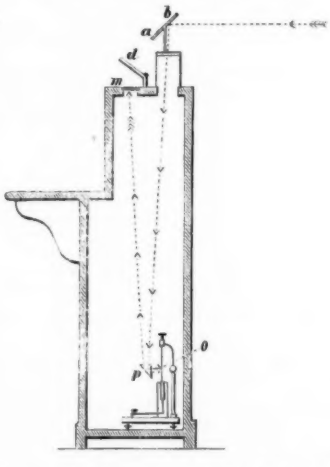
and its scale, are separate from each other; it is possible they may put each other out; and, moreover, the adjustment necessary at the commencement of every measurement is a delicate matter. The writer has often been told that this method of arrangement, excellent though it be for laboratories, is too complex for industrial purposes.

Another reason, which might at first sight cause surprise, is this: it frequently happens that there is no sufficient space for the arrangement; the two parts of the apparatus do not of themselves occupy much room, but the luminous ray which connects them is 1 m. in length, and in some workshops the space is so taken up that it is impossible to afford even this amount.

It occurred to the writer that, with a view to rendering the use of the mirror general, it would be interesting to construct an arrangement in which the scale should be invariably connected to the galvanometer, and in which the luminous ray might occupy less space.

The following is the plan suggested.

In the lower end of a wooden box of about 1 m. in height, 0 m. 50 in width and 0 m. 30 in depth, place a Deprez d'Arsonval galvanometer for instance, and in front of the mirror, *o*, a prism whose total reflection is *p*; within the opening at the upper end



of the box insert the transparent divided scale, *m*; the luminous ray will pass through a hole which has been previously bored, and, if the distances have been properly set, the image of the fine wire placed in the hole will be at *m* on the divided scale.

Observe that by means of this arrangement the difficulty with the luminous ray has been got rid of; the ray being no longer in plane but vertical.

To complete the arrangement the author has fitted the box with a tablet for the instruments used for measuring, viz., the resistance boxes, condensers, keys, &c. This arrangement allows of the experimenter being seated; in addition there is a mirror, *d*, above the scale which reflects the results of the measurements.

The light is thrown on the galvanometer by means of a double movement mirror, *a*, *b*, similar to that used with ordinary divided transparent scales.

There is likewise a small size incandescent lamp which may be substituted for the mirror *a*, *b*; this gives a splendid spot.

The available space at either side of the galvanometer is occupied by the cells of a battery, both poles are connected to terminals at each side of the apparatus.

Progress in Newcastle.—The work of the electric light companies is progressing rapidly. The Newcastle and the District Electric Company, Limited, will, by the end of the month, be supplying 5,000 ten candle-power lamps. The Electric Supply Company is very busy and fresh orders arrive daily.

ON THE ACCIDENTS CAUSED BY OVERHEAD WIRES IN NEW YORK.

(FROM A CORRESPONDENT.)

THE accidents caused by the use of overhead wires for electric lighting and other purposes in the United States, and especially in New York, are still a very welcome subject to reporters for filling the columns of daily papers with alarming, though in most cases absolutely unfounded or very much exaggerated, tales of unhappy victims to the high-tension current systems. I am now in a position to furnish you with extracts of two letters, the contents of which throw a very strange light upon the promoters of such tales, and I think it might be interesting to bring these extracts to the knowledge of your readers.

The first of the said extracts runs as follows:—

"As regards the contents of your letter and the queries you raise, I have not the necessary details at hand to answer it *in extenso*, and therefore I will limit myself to give you a few general facts. There are two fairly large stations using alternate current transformer systems in New York City—the one uses the Westinghouse, the other the Jennie system, but almost *all* the arc light stations, of which there are five or six, have one, two, or three alternate current dynamos in operation. The Edison Company have in all three large stations supplying, I should say, some 50,000 lamps. The arc lamp stations supply some 10,000 arc lamps, using dynamos giving 1,500 to 3,500 volts. The very careless and reckless way the wires are run (in New York particularly) and the very poor insulation of the wires, and the fact that telephone, telegraph, fire alarm, power circuit (600 volts), arc light and alternate current transformer circuits, are even sometimes run on the same poles, give results that costs human lives. Of the condition (now being improved) of the circuits overhead you can form no conception, nor would any description give an adequate idea of the criminal state in which the wires were only a year ago, it is only a wonder that very many more accidents did not happen.

"As for the evidence that the deaths were caused by alternate circuits or direct current, it is difficult to get any evidence, nor could they find out in many cases from the fact that many deaths were from contacts with telephone or telegraph wires, and the lighting circuit at points other than where the accidents took place. The adversaries of the alternate current system claim that the rapid increase of deaths is due to the high tension alternate current circuits, and adduce as proof that the rapid increase of deaths from electric lighting circuits begun at the time these high tension alternate current systems begun to be introduced. But probably the more rational explanation is that the insulation in the last two years has deteriorated so as to offer no protection at all for the wires."

The writer then proceeds to say that undertakers of alternate current transformer plants in European countries have already to meet with difficulties arising from the public being alarmed by the electrical "atrocities," and that he had to take a trip to . . . to reassure the electric company there, as some enemy had inserted a systematically prepared series of extracts from American papers in the local papers of the respective town.

The writer of the second letter, above referred to, is residing in New York, and is very well acquainted with the mysteries of American competition in the electrical concern.

"It is absurd to state," he says, "that any four hundred people have been killed. I think thirty-three (33 !) is the entire number chargeable to any system of electric lighting. In considering the question of these deaths you must bear in mind that the business of electric lighting in America has been practically unrestrained by Governmental regulation. Hence all sorts of wires have been strung in all sorts of ways, and the wonder is, not that deaths have occurred, but that they should

have been so few in number, considering the extreme carelessness of the electric companies.

"I quite agree with you that the articles appearing in Europe are inspired by those having the destruction of the alternating system at heart. Advantage was taken of the popular excitement to print many articles, and to say many things which were totally untrue, in this country, and the same plan is now being pursued in Europe. The alternating current system in this country is making tremendous strides, necessarily to the detriment of those companies using the continuous or direct system."

In the midst of these attacks against the alternate current transformers, this system has been victorious in Germany, where the Municipality of Cologne has just decided to erect a large central station on the converter system, and this will be the first town in Germany to be lighted with electricity distributed by alternate current transformers.

THE ELECTROTECHNICAL INDUSTRY.

THE present time is one in which greater activity is being shown in this country in the various branches of the electrical industry than has ever been the case previously. Probably the main reason for this satisfactory state of the electrical trades is to be found in Lord Thurlow's Electric Lighting Act of 1888, which effected many beneficial alterations in the Act of 1882, by removing most of the obstacles in the way of the efficient development of electric lighting. Another reason is the fact that since the first Act was passed electrical engineers have devoted greater attention to the perfecting of details in dynamos, lamps, insulation, &c.

It may perhaps be interesting if a few instances are mentioned showing the condition of business now prevailing. The large electric supply companies are, apart from the central stations, doubtless taking the lion's share in the present prosperity. A year or two ago, before these companies were formed or amalgamated with others of the same kind, the business transacted by the then small fry was of a very limited character; but since their establishment on a sound basis, their sphere of work has been greatly augmented. To show to what extent this is the case, we may state that the number of men employed in the workshops has in about a year been doubled in at least two important instances we have in mind at the moment. One department in this branch which is assuming large proportions is the production in iron, brass, copper, copper and brass, and even silver, of artistic fittings, especially as regards pendants, brackets, shades, lamp standards, &c. This class of goods is, of course, principally used in West End establishments and in the residences of wealthy people. In fact, many customers flatly refuse to have anything fixed in their residences which is not of a novel and artistic style; hence the great attention now being paid to this kind of fittings. Another feature in this branch of trade is the gradual springing into existence of small supply firms. The business of these is mainly confined to small installations and the profits accruing therefrom are proportionately small. The makers of dynamos, motors, engines, all kinds of meters and other appliances are exceedingly well employed; and the manufacturers of incandescent lamps are *for the present* having their day; but when their monopolies come to an end, lamps will be much cheaper and will form not an unimportant item in the cost of putting up an installation. In the cable and general electric light conductor branches the business done is proportionate to that in the allied departments.

It is, however, in electric traction that a boom is coming in the near future. There are already about twenty applications for the consideration of Parliament during the present Session for powers to employ electric tramcars. In addition to these, many provincial authorities and tramway companies are seriously considering the advisability of substituting electric for horse traction. This will be evident when we mention that one company is continually receiving applications for particulars as to the initial expenditure necessary for the introduction of a few electric tramcars as a beginning, with a view to the whole system being eventually worked entirely by electricity. Another application was received by the same company from Norway, regarding the erection of an electric narrow gauge railway about 150 *miles long*.

The general condition of the various electrical branches of industry is very prosperous, and in order that this may continue to be the case, electrical engineers should devote more time to the consideration of details in their respective branches, so that all work done shall be executed in as efficient a manner as possible. Wherever this policy is adhered to success will be the result, and the confidence of the general public greatly increased.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from* Vol. XXV., *page* 445.)

IN the last contribution which appeared in this Journal the action which takes place in plating baths was briefly analysed, and to avoid complexity of description the resistance opposed by the baths was regarded as being practically the whole resistance encountered in the circuit, the internal resistance of the voltaic cell being assumed to be small enough to be negligible.

It was stated that as the resistance of the circuit would be three times as great when there were three baths in series, the breaking down and building up at the anodes and cathodes in *each* of them would proceed at one-third the rate of what would occur when there was only one bath in the circuit, but as there are *three* baths in which the breaking and building up is taking place the total weight of metal dissolved at the anodes and deposited on the cathodes would be the same in both cases.

Theoretically, as well as practically, the number of baths which can be advantageously arranged in series is limited, for the reason that a certain potential in the current is necessary to break down metallic structures. Assume the difference of potential between the poles of a voltaic cell = 1 volt in the air, the difference of their potential when the circuit is completed through one or three baths would, *under* the conditions assumed, be approximately one volt; of course the difference of potential between the two poles would be a little higher when there are three baths in circuit than when there is only one, but practically it would be the same, on the assumption that the internal resistance in the voltaic cell was very small indeed compared with that of the plating baths.

Now, as the difference of potential when the circuit is closed can only approach to, and never exceed under the most favourable conditions one volt, and as it is divided over the whole circuit it follows that the difference of potential between the anodes and cathodes in each of the baths must be reduced correspondingly to the number of plating baths joined in series, for example, if there be but one bath in the circuit the difference of potential between its anode and cathode will be approximately one volt, if there be three baths in series then the difference of potential in each of them will be reduced to one third of a volt, and if the number of baths included in the circuit be, say, one hundred, then the difference of potential between the anodes and cathodes of each of the baths would be reduced to the one-hundredth of a volt.

To break down and build up metallic structures the current must have a certain given potential and if the difference of potential between the anodes and cathodes be reduced below a certain point no breaking down

will occur, the electrodes will, however, become statically charged to a low degree and this statical charge, or polarisation, as it is commonly termed, will oppose the development of current by increasing the resistance of the circuit, but however numerous the baths may be, the writer believes he may venture safely to assert that more or less current would pass through the circuit, but not electrolytically, and in such case we should have an example when the energy associated with an electric current was very small in amount, of an electrolytic conductor behaving as a metallic one, and on the other hand when the energy associated with a current is sufficiently great to burst up a metallic conductor we have such conductor behaving as an electrolytic one.

It would seem to be very generally considered by mathematical physicists, that lightning and Leyden jar discharges are oscillatory. The writer himself ventures still to hold the opinion that they are not so. Undoubtedly, under certain conditions, electrical waves can be set up in a conductor, but it is thought that the waves produced are to be traced to the alternate storage and dissipation of energy in the form of magnetism developed in matter.

Physicists admit that oscillation involves inertia; few, if any, will deny that inertia and weight are convertible terms, and that specific gravity expresses the special relationship of the varieties of matter to the force gravity.

For electricity to oscillate it must possess the properties that oscillation involve. Undoubtedly electricity possesses what may be argued to be as of the nature of mass, viz., quantity, but we speak also of quantity of heat apart from it potential, the energy of heated matter being the quantity of heat multiplied by its intensity or potential.

Now, as electricity is always associated with matter and cannot be added to or taken from it, it seems only reasonable to regard electricity as partaking more of the nature of matter than energy does, but still it cannot be considered to be matter, as it does not possess the distinctive property of all matter, viz., weight, and, therefore, it seems to follow that if electricity be regarded as being an entity capable of oscillating, physicists must assume either that oscillation does not involve inertia or that inertia and weight are not convertible terms.

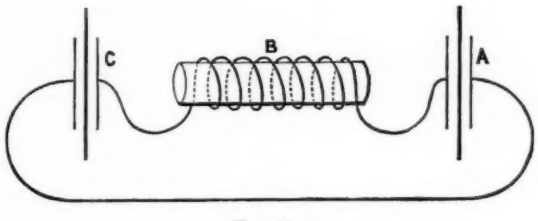


FIG. 10.

The writer considers that the electrical oscillations which have been observed, have been produced somewhat in the following way :—If a charged condenser, A, be connected through convolutions of insulated wire surrounding a soft iron core, B, to a second uncharged condenser, C, as indicated in fig. 10, electricity will flow from A, through the convolutions of insulated wire into the condenser C, lowering the potential of A and charging C, until the statical charges of both condensers have similar potentials, magnetic inertia and self-induction are encountered in the path of discharge and the overcoming of this means a storing up of energy as magnetism in the iron and convolutions of insulated wire, B. So soon as the electrical potentials of the two condensers approach equalisation, demagnetisation occurs, the energy stored up at B, developing current and continuing the flow into C and raising the potential higher than that of A, electricity now flows back from C to A again, storing up energy at B, which is afterwards given out as current charging, A, a little higher than C. In this way it is conceivable oscillations may be set going, but no true discharge has occurred.*

Now, if electricity were pumped alternately backwards and forwards from one condenser into the other, much stronger oscillations would be set up in the conductor connecting the condensers, and the experiments chiefly relied upon for demonstrating that electric discharges are oscillatory have been made with induction coils. Magnetic inertia and self-induction play the leading part in the development of electric alternations in the secondary wire of an induction coil, and with such apparatus it is not difficult to conceive that as a consequence of the storage of energy in the soft iron core and the self-induction of the convolutions acting and reacting upon one another oscillations much more rapid than those more immediately due to the opening and closing of the primary circuit may be set up in the secondary wire. The writer thinks that the electrical oscillations which have been observed have been produced in some such way as he has suggested, and that they are attributable to the magnetic inertia of matter and not to the inertia of electricity, and, further, that the conditions under which they have been produced have not been those which prevail when a true discharge occurs. The fact that electrical currents through conductors do not cease instantly, but are prolonged during the demagnetisation, does not suggest oscillation.

The conditions which prevail when a discharge between the clouds and the earth takes place are altogether different to those where alternations are set up by induction. In the case of lightning, the only thing which prevents discharge is the dielectric barrier separating the + and the − electricities of the clouds and the earth. So soon as the energy accumulated in the form of statical charge exceeds the cohesive force of the dielectric, the barrier gives way, and as the heat developed in the path of discharge is directly as the resistance, the whole of the energy expended in breaking down the barrier is accounted for; but the barrier is broken down at the commencement of discharge, and the greater part of the discharge flows through a path whose resistance has been reduced by the heat developed in the act of breaking down the air molecules, and consequently there is a considerable amount of energy to be dissipated through the medium of the lightning conductor.

Faraday demonstrated that the inductive capacity of solid dielectrics is greater than that of gaseous matter; in other words, that gaseous matter is theoretically a more perfect insulator than a solid dielectric; his experiments went to show that all gasses possessed the same inductive capacity, and that it made no difference whether they were dense or rare.

In a solid dielectric the number of molecules in a given space through which induction can occur is much greater than in gaseous matter, and the superior inductive capacity of solid dielectrics is probably due to this cause; but it has been pointed out in an earlier portion of this article that it is the cohesive strength binding the molecules of the dielectric together which practically determines their efficiency as insulators, and, for the reasons given, glass, notwithstanding that it is capable of transmitting induction through it with greater facility than atmospheric air, is very much more efficient as an insulator than gaseous matter.

When the pressure of air in a receiver is reduced by means of an air pump, its conductivity to high tension discharges becomes greatly increased, but as is well known, there is a certain degree of attenuation which opposes the least resistance. Some experiments tried by the writer more than 20 years ago seemed to indicate that the stage of least resistance was reached when the elasticity of the air in the receiver balanced

* The writer is by no means sure oscillations would be set up this way. The demagnetisation would commence, he thinks, before the second condenser had reached the same potential as that of A, and the extra current due to demagnetisation might simply equalise the potentials of the two condensers.

a column of mercury one-tenth of an inch high. At that time the writer could not command very high vacua; but it would be very interesting to determine the law which governs the resistance opposed by vacua after the stage of least resistance has been passed, and there would be no real difficulty in doing so with the aid of such pumps as are now available. The writer himself is disposed to believe that the resistance opposed after the stage of least resistance has been passed would be found to increase in a much more rapid ratio than the rate of decrease of the air molecules in the partially exhausted receiver.

All practical experiment goes to show that induction follows a similar law to that which governs conduction, confirming Faraday's view that induction and conduction are the same in principle and action. The explanation of Faraday's observation, that rare and denser air have the same specific inductive capacity may be that as rare air (within certain defined limits) is a better electrical conductor than denser air, the increase of conductivity due to rarity balances the greater inductive capacity which denser air ought otherwise to have.

The higher the vacuum the fewer the molecules in a given space, and the greater will be the distance of the centres of the molecules from one another. Now, if induction and conduction be the same in principle and action they should follow similar laws. The writer is disposed to think that the decreased electrical resistance which moderately low vacua oppose is not a *true* increase of conductivity. Gaseous dielectrics he regards as electrolytic conductors of very high specific resistance, electrical discharge through them involving a bursting up of the atomic constitution of the molecules similar to that occurring in a plating bath.

Our atmosphere may be regarded as a dielectric structure held together by pressure, the higher the pressure the stronger the structure, and the greater the electrical pressure that is requisite to produce a path of discharge. Removing the pressure weakens a gaseous structure, and a lower electrical pressure is then capable of breaking it down.

Matter is essential for an electrical path, but at the moment preceeding disruption the energy is *almost* wholly concentrated on a row of molecules arranged in a line by induction, and *not* on the *whole* of the structure.

In the earlier stages of exhaustion the gaseous structure becomes weakened directly as the pressure becomes less, at the same time there is an abundance of molecules out of which paths of discharge can be formed.

After exhaustion has proceeded to a considerable degree the reduction of the molecules in the partially exhausted receiver begins to tell, and when the pressure has been brought down to about $\frac{1}{300}$th part of the normal atmospheric pressure the stage of least resistance would seem to have been reached. A further degree of exhaustion brings about an increase of resistance as there is a smaller number of molecules out of which paths of discharge can be formed, and this should affect induction equally with conduction; and, therefore, it would seem to follow that as the conductivity of the vacuous space becomes less so also should its inductive capacity become reduced.

If, after a fairly high vacuum has been produced, the air remaining in the exhausted receiver be further reduced by pumping to, say, half the quantity, the molecules through which induction and conduction can occur will be reduced to half the number; and, as the atoms of which molecules are composed must have some definite size, the distance separating the centres of the molecules will be necessarily more than twice as great; it would, therefore, seem probable that the resistance opposed to the passage of electricity through high vacua would be found to increase in accordance with some rapid law as the vacuum became higher; and, the logical sequence, assuming the reasoning to be correct, would seem to be that an absolute vacuum is an absolutely perfect insulator to induction as well as to conduction.

The experiments which have been suggested should have a bearing, it is thought, on Maxwell's hypothesis which attributes all magnetic and electric phenomena to stresses of the ethereal jelly, they would certainly demonstrate one of two things, either that induction and conduction are the same in principle and action, or that they are not so, and such demonstration would be of value. If, as the writer himself anticipates, high vacua should be found to resist induction through them equally with conduction, additional evidence would be obtained of the connection existing between matter and electricity, and it might be almost safely concluded that where there is no matter there can be no electricity, and where there is no electricity there can be neither induction nor conduction, and, further, as energy passes through the highest vacuum obtainable, there is in this respect a crucial difference between electricity and energy.

Leading physicists, including Sir W. Thomson, have arrived at the conclusion that an electric current commences to flow through the outer skin of the conductor, and that the central portion of a conductor is comparatively idle to discharges of short duration or to rapid reversals developed by an alternating current dynamo. It has been stated in this as well as in previous articles the writer finds himself unable to accept the newer view of electric conduction, but before giving the reasons which lead him to conclude that *all* currents, be they continuous or alternating, travel somewhat faster through the centre of a conductor than through its outer skin, he wishes it to be understood that the whole of what is put forward in support of his contention must be considered as subject to experiments he has not yet been able to try, but for the carrying out of which he has seen his way to designing the necessary apparatus. The writer feels the less compunction in freely expressing his views because he considers the matter in dispute can be set at rest by direct experiment with comparative facility.

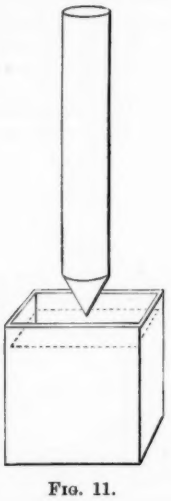


FIG. 11.

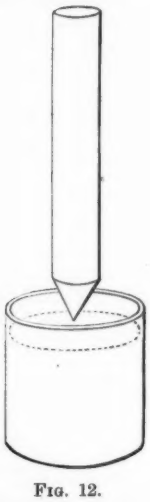


FIG. 12.

In considering a question such as the manner of conduction the subject must be looked at broadly, and not simply from an electrical treatise point of view, and therefore it seems necessary to say a few words in reference to motion as well as to magnetic inertia and self-induction.

Motion, as the term is commonly understood, may be defined as a product of energy and matter, for all motion is relative to matter, and all motion involves matter.

The active principle of every mode of motion, be it atomic or electrical, molecular motion or bodily motion, is energy, and in all the varied operations of nature energy may be said to be speaking to us. She speaks, it is true, in more than one language, but matter is invariably her interpreter and the medium through which she speaks. It is not too much to say this fact is not sufficiently recognised.

All those who find pleasure in research almost necessarily form for themselves, it may be quite unconsciously, a working theory of some kind, and although the writer maintains that the scientific uses of the imagination should be reserved rather for private consumption than for public enunciation, still, as he is opposing generally accepted views, and as he thinks what he is anxious to put forward will be rendered somewhat clearer by his describing a working theory that has grown upon him, he proceeds to do so in a series of propositions expressed with a view to brevity somewhat dogmatically.

1. All the phenomena of physics are reducible to two principles, viz., energy the source of all force and inertia, the distinctive principle of matter as contrasted with the forces associated with it.

2. That as the varied descriptions of matter possess inertia in different degrees, and a mass of matter is capable of opposing resistance directly as its specific gravity or the amount of inertia it possesses; this inertia, which forms its distinguishing feature, and is indissolubly associated with it, may be regarded as negative energy.

3. That matter can be set into motion only by additional or positive energy being imparted to it; and as such positive energy is not in any way essential to the constitution of matter, it can be parted with under certain conditions.

4. That matter and energy are concerned in all physical acts and every mode of motion, and therefore all motion, be it electrical or atomic, bodily or molecular, may be regarded as a product of matter and energy.

5. That matter not only resists being put into a condition of bodily motion, but it opposes resistance to internal motion, whether it be atomic or molecular motion, and the effect of such resistance is to bring about a separation of the positive energy which has set the matter in motion, and this separation may occur through a series of transformations or modes of motion, the energy becoming eventually dissipated in the form of heat radiation.

6. That electricity is an attribute of matter, and is concerned in the atomic constitution of the molecules of all matter.

7. That electrical motion is energy acting on matter through the medium of the atoms forming the molecules, and that an electric current is primarily atomic motion inside the molecules of matter.

8. That chemical motion, or affinity and electrical motion, are convertible terms.

9. That whenever a transformation of energy occurs, the immediate cause of such transformation is inertia, the transformation brought about being directly as the energy of motion arrested.

10. That modes of motion may by a reflex action give rise to other modes of motion.

11. That similarly as when a billiard ball is struck a certain amount of heat motion is developed as well as bodily motion, so when heat motion strikes a conductor, the inertia opposed by the conductor to setting up of of heat motion causes the development of a certain amount of electrical motion, and in this way thermo currents are produced.

12. That electrical motion may differ from heat in being a more rapid internal motion in matter, the potential of an electric current increasing as the rate of motion increases, and its energy increasing as the square of its velocity, harmonising in this respect with what is observed in the case of a moving rifle bullet or other matter in motion.

The views above given are not in any way insisted upon, but they have been described because they seem to their author to connect in one continuous chain the various transformations of energy physicists are familiar with.

Energy being indestructible there can be no such thing strictly speaking as a conversion of energy, but to use the words of Maxwell, "it may be transformed into any of the forms energy is susceptible of."

Energy is only visible when clothed, and although we become acquainted with it in a variety of dresses, matter is invariably the material out of which the dresses are made.

As all motion is a transmission of energy, and matter is always more or less concerned in its transmission, it would seem to follow from what we observe of the operations of nature that energy transmitted through the medium of matter in the form of an electric conductor should harmonise generally with its transmission through matter in the form, say of water, and it seems to do violence to one's common sense to be told by mathematicians that this is not so.

It will be convenient at this stage to make a brief reference to magnetic inertia and self-induction.

(*To be continued.*)

ELECTRIC LIGHTING PROJECTS IN BRUSSELS.

AT the fourth—and last—of the series of lectures on the above subject, to which we have already made reference, M. E. Bède, a Communal Councillor of Brussels, devoted his attention particularly to the transmission of energy by compressed air. In a lecture, which was listened to with great attention all through, M. Bède described the installations of the Popp system at Paris, which had adopted transmission by compressed air on a very large scale. This mode of transport of power gave sub-products of an important value in a large city. By the expansion of air they could accessorily create freezing apparatus which would be very useful in many establishments, and consequently would yield good receipts. The lecturer examined in detail the net price, which was not less than 20 c. per horse and per hour in Paris. M. Bède was of opinion that compressed air—which, it is true, was established at Paris when no competing system was in the field to dispute the matter with it—might have a future before it. That depended entirely on local conditions. Its advantages increased with the number of consumers of cold air. Still, and in an absolute manner, the direct transport of electricity remained more economical than the employment of compressed air. It was on this account that the Parisian company established direct electrical transmissions in quarters where the consumers of the "sub-products" of compressed air were wanting. How, under these circumstances, said M. Bède in conclusion, could one dream, as M. Van Rysselberghe did, of the employment of water under pressure, which had none of those accessory applications allowing of an increase in the receipts. This water gave in energy a yield less than that of compressed air. Consequently, concluded the lecturer, M. Van Rysselberghe's system, which had no past, could not hope for a future.

M. HAMACHE said that the "sub-products" which had been vaunted could only arise from losses of motor power, and consequently an increase of expense for the customer. M. Hamache, frightened also at the dangers which high tension electricity might present, extolled the Van Rysselberghe system, despite all its drawbacks.

M. LUCIEN ANSPACH answered M. Hamache to the effect that water showed more loss than air; but for water these losses were not utilisable in any manner at all. As to the dangers of electrical transmission, the accidents which had happened in America were due to the employment of alternating currents, while the adoption of continuous currents, which were harmless, as an already long practice had proved, was recommended in their case. M. Anspach also insisted on the comparative advantages of air and water for the transmission of power, and showed very clearly that water was, without any hesitation, the most defective among the whole of the methods of transmission.

M. VAN RYSSELBERGHE again devoted himself to the defence of his system. The speaker granted that the transport of energy by air might have advantages over transport by water—if it were a question of transport and not of utilisation. What it was necessary to distinguish among the different means proposed was that

which allowed of the employment of the simplest and most economical motor, and in that connection his motor was a fact which cut short all discussion. Then M. Van Rysselberghe asked the Administrative Commission of the Society of Engineers (before whom the lecture was delivered) to appoint a disinterested jury who should make experiments with his motors and state merely what they saw.

M. LEGRAND, who presided, thanked those who had spoken, and then closed the debate, which will doubtless throw some light on the important decision which the Brussels Communal Council has now to come to.

ELECTRIC LIGHTING IN HANOVER.

TENDERS for the electric lighting of the Town of Hanover have been submitted by the following firms: The German Electrical Company, of Aix-le-Chapelle, the Helios Company, of Cologne, Messrs. Siemens and Halske, of Berlin, and Messrs. Schuckert and Company, of Nuremburg.

The lighting is to comprise 8,000 lamps at first, with a system of cables capable of ultimately feeding 15,000 lamps. The total consumption of energy for supplying the whole town is estimated at about 1,000 horse-power.

The Aix Company's proposal includes seven steam engines running at 180 revolutions per minute, seven dynamos, seven boilers, and a battery of accumulators, sufficient for maintaining 4,000 lamps during 3½ hours. The two-wire system is to be employed with a tension of 100-135 volts.

The Helios Company proposes the employment of six steam engines running at 85 revolutions per minute, six Zipernowsky alternating machines, and nine boilers. The system is to work at a tension of 2,000 volts. The tender of Messrs. Siemens comprises three steam engines running at 150 revolutions per minute, three dynamos, four boilers, and a battery of accumulators, sufficient to feed 4,000 lamps during 3½ hours. The three-wire system is to be adopted, with a tension of 220-253 volts.

Messrs. Schuckert proposes to employ three steam engines, three dynamos, five boilers, and a battery of accumulators, capable of supplying 6,400 lamps during 3½ hours. The three-wire system is to be adopted with a tension of 214-234 volts.

In addition to the public and private lighting, it is intended that the installation shall be employed in the electrical transmission of power for various industrial purposes. The municipality has placed the tenders before M. W. Kohlrausch for examination.

REVIEWS.

Laxton's Builder's Price Book for 1890. Seventy-third Edition. London: Simpkin, Marshall & Co., Stationer's Hall Court.

The chief points of interest in the present edition of this invaluable work are perhaps the sections dealing with electrical matters. As regards electric bell fittings, the information is fairly definite, though the prices given in several cases are excessive; thus we have hard wood pushes priced at 2s. 3d., but they can certainly be obtained at one-third this price. Again, Leclanché cells are priced at 5s., small size; this is about double the retail market price; in contradiction to this, however, under "telephones" we find Leclanché cells, medium size, priced at 2s. 6d. We may remark that electric bells are wrongly indexed as regards the number of the page. In the case of electric light fittings, the person who searches for information as regards the cost of fitting up his house complete, will be somewhat bewildered, Messrs. Crompton & Co., giving the price of a complete installation, including engine (gas), for 150 20-C.P. lamps at £580, whilst Messrs. Drake and Gorham give for 150 16-C.P. lamps a price of £690, a pretty wide difference.

Elementary Manual of Magnetism and Electricity. By Prof. JAMIESON. Part II. Voltaic Electricity. London: Charles Griffin & Co., Exeter Street, Strand.

This book consists of a series of 12 lectures, being a continuation of the series, Part I. (On Magnetism), published a short time ago. The very practical nature which distinguishes Prof. Jamieson's style of discourse is again prominent in the present production; indeed, we cannot imagine a series of lectures of the kind in which the professional and practical spirit is better combined.

The Compass on Board Ship. (Der Kompass au Bord.) Hamburg: L. Friederichsen and Company, 1889.

The German naval observatory at Hamburg has for several years carried on a careful inquiry upon the deviations of the compass due to magnetism in iron ships, and as a result of these investigations, combined with the work executed in this direction in England, Dr. Newmayer, the director of the observatory, has compiled the work under notice for the use of officers of the mercantile marine.

The work deals with, among other subjects, the magnetism of iron and steel, terrestrial magnetism, the various forms of the mariner's compass, the magnetism of ships and resulting deviation, and with the changes which take place due to change of latitude.

In the chapter treating of the various modern forms of compasses, the text is far from being up to date with regard to the description of Sir W. Thomson's compass, and the author scarcely proves his contention that the Heckelmann compass card, which is credited with being an improvement on the Thomson, is in any way superior, or even equal, to the modern form of the latter. The work, as a whole, no doubt possesses a certain value, affording as it does some considerable practical information as well as theoretical instruction.

ON THE GALVANIC POLARISATION OF PLATINUM ELECTRODES IN DILUTE SULPHURIC ACID.

By FRANZ RICHARZ.*

THE most important result of the author's measurements of polarisation with the Helmholtz pendulum interrupter is that, even with platinum wire electrodes of very small surface, the galvanic polarisation in dilute sulphuric acid assumes no higher value than about 2·5 Daniell. The highest values were found for an intensity of about 0·001 ampère (of course, lower intensities for smaller electromotive forces of the polarising battery give lower values for the polarisation); with higher intensities there resulted lower values of polarisation, 2·4 Daniell at about 0·4 ampère. The decrease with increasing intensity will probably have to be ascribed to the greater heating of the liquid.

Since the result that the polarisation even with the greatest current densities does not exceed 2·5 Daniell was assumed in advance, the consequent dependence of the resistance of the decomposition cell on the intensity has been calculated in the first part of this inquiry.

There occurs, finally, a question in connection with galvanic polarisation in currents of great density—namely, what is the influence upon such polarisation

* This is not an independent paper, but the conclusion of a memoir of which other portions have appeared formerly.

of the simultaneous formation of ozone, hydrogen, peroxide, and persulphuric acid. These peroxides yield on spontaneous decompositition ordinary oxygen, in comparison with which they possess a larger store of energy. It might, therefore, perhaps be expected that their formation would increase galvanic polarisation as against the case of the liberation of ordinary oxygen. But under the circumstances of the author's experiments, *i.e.*, small surface of the anode, low temperature and sulphuric acid containing 40—50 per cent., large quantities of the peroxides were formed at high intensities, but at low intensities scarcely any. From the measurements of polarisation which have been instituted, and which at all the intensities used gave approximately the same value, it must therefore be concluded that the formation of the peroxides has no considerable influence upon polarisation. As regards hydrogen peroxide this appears as a matter of course, since, according to the author's former researches, it is formed only by a secondary and purely chemical process from the persulphuric acid which has been primarily formed. As for the latter, the author has shown by measurements of the electromotive force of the elements: platinum (sulphuric acid), persulphuric acid (platinum), that the polarisation of the anode alone, if exclusively persulphuric acid was formed at it by a reversible electrolytic process, must be about 0·6 Dan.—a value not higher than is otherwise obtained for the minimum of the polarisation of the anode alone, in which there occurs a visible liberation of ordinary oxygen.

Hence, as the formation of persulphuric acid and ozone does not exert a demonstrable influence upon the galvanic polarisation, we may conclude that the primary electrolytic process which chiefly determines the magnitude of polarisation is, other circumstances being alike, the same on the liberation of ordinary oxygen as on the formation of ozone and persulphuric acid. This process can be recognised in the transit of the electric charges of the ions to the electrodes; the potential difference of the electrodes, which is required to deprive the ions of their charges, is, in case of electromotive forces which occasion a visible decomposition of water, polarisation. In the case of the electrolysis of dilute sulphuric acid, the question is that the oxygen of the anion, SO_4 or $H\,SO_4$, is deprived of its negative charge, and the cathion H of its positive charge. This process primarily determines polarisation, whether there may be a subsequent formation of persulphuric acid, ozone, hydrogen peroxide, or ordinary oxygen.

One consequence must still be mentioned. If the polarisation and the work of the electric current expended upon electrolysis are one and the same, whether there is a formation of ordinary oxygen or of ozone and persulphuric acid, then necessarily the secondary generation of heat in the decomposition cell, corresponding to the secondary transformations of the ions must, *ceteris paribus*, be so much the greater on the formation of ordinary oxygen than on the development of the peroxides as corresponds to the liberation of heat on the spontaneous decomposition of the latter.—*Annalen der Physik und Chemie.* Vol. XXXIX., Part II., 1890.

THE SAINT-OUEN-LES-DOCKS CENTRAL STATION.

A CENTRAL electric light station is now in course of erection at Saint-Ouen-les-Docks, near Paris. It is being constructed by the Society for the Electrical Transmission of Power for the purpose of feeding the cables in that part of Paris where the company has a concession, and also for supplying with light the towns of Asnières, Saint Denis and Saint-Ouen. The station, which is being laid out for a total capacity of 12,000 10 C.P. lamps, will transmit current at 2,400 volts pressure to sub-stations established in Paris, Asnières and Saint Denis, where it will be transformed and distributed at 110 volts. At the Saint-Ouen central station the machinery, when completely installed, will comprise eight boilers of the Roser type, four Corliss steam engines, each of 300 H.P., and seven alternating current dynamos of the company's type, giving 30 ampères at 2,400 volts pressure. These alternators will be excited by four Hillairet dynamos of 250 ampères, by one dynamo of the company's make giving 500 ampères, and by a Sautter dynamo also of 500 ampères, the E.M.F. of all being 110 volts. In addition to supplying energy for exciting the alternators, these dynamos will furnish current to the lamps fixed in the central station, to those installed in the manufactories in Saint-Ouen, and for the transmission of power for the elevating pumps. A battery of accumulators completes the generating station. The *Bulletin International de l'Electricité* asks what use will be made of the station machinery during the day time, and suggests that it should be employed for the electric purification of the sewage, since the expenses in this direction would be small. Moreover, the field where the Paris Municipality conducts experiments with sewage is situated near the station. Our contemporary says the distance is insignificant, and rather humorously asks what this matters to the Societé Marcel-Deprez, who cannot have forgotten that the efficiency is independent of the distance.

NOTES.

The Electric Light Question at Leamington.—There was an animated discussion at Monday's meeting of the Leamington Corporation on the report presented by the deputation appointed to inspect electric works elsewhere. The report stated that the deputation had inspected the works at the National Liberal Club, London, where there are 700 lamps of 16 candle-power, each at a cost of £1 per lamp per annum, They were also taken over the works at Paddington Station, designed and carried out by Mr. Gordon. In Mr. Gordon's opinion a considerable reduction would take place in the cost of arc lamps before long, and lamps now costing £14 might be obtained for one-fourth of that price and equally good. The deputation were of opinion that the street electric lamp used in Leamington, and which is only 16 candle-power, would be good if the lamps were kept properly cleaned and more frequently renewed. Looking at the very great development taking place in electric lighting, and knowing that the best electricians are engaged in making further improvements, and that Corporations can obtain provisional orders at much less cost than public companies, the deputation recommended that the Council apply for a provisional order to enable them either to carry out works of their own, or to licence a company with whom they would be able to arrange suitable terms. Mr. Crowther Davies complained that a document of such great length had only been placed in the hands of members two hour before the Council met, adding that it did not, however, much matter, as there was nothing in it. A proposal to defer the consideration of the report till a special meeting had been summoned was negatived. Alderman Wackrill (Chairman of the Watch Committee) moved the adoption of the report, and explained its principal provisions. After some discussion the report was agreed to.

Portable Lighting Stations. — Some Continental railway companies have adopted a system of movable electric lighting plants on their lines. The object is to have a light at hand for application at any given point for important purposes, such as the lighting of the scene of an accident, the disembarking of troops, &c. Two kinds of plants have been suggested, one being a locomotive surmounted by a dynamo.

Electric Light in Breslau.—The municipal authorities of Breslau have given the contract for the electric lighting of their town to Messrs. Siemens and Halske, of Berlin. The central station will be situated at the Carmelite Barracks, and power will be provided for an installation of 8,000 incandescence lamps, to be ultimately increased.

Electrical Lighting in Spain.—The English company, the Electrical Supply Company of Spain, has published its prices, which are enormous. The Compania Madrilena de Electricidad has not yet given prices, but they are expected to be very high. The excessive charges are not to be wondered at when it is remembered that gas in Madrid is at 9s. per 1,000 cubic feet.

Electric Lighting Acts and Scotland.—A number of representatives of Scottish Corporation interests met at Dover House on Monday afternoon on electric lighting questions, and had an interview with the Lord Advocate and Mr. Courtenay Boyle, of the Board of Trade, on the proposed amendment of the Electric Lighting Acts as applicable to Scotland. It appears that several of the Corporations in Scotland had made representations to the Board of Trade as to the lines on which amendments of the Act should, in their opinion, proceed; and it is understood that in the case of Edinburgh and Leith, both of which Corporations were represented at the meeting, the desire is to have the Town Council in each case named as the local authority for electric lighting purposes. The Board of Trade, at the end of the interview, indicated that the views of the various bodies represented would receive due consideration.

Electric Light for Weybridge.—The whole of the town of Weybridge is to be illuminated this week with electric light. The place has been divided into three circuits, so that, in the case of an accident to any of the wires, only one-third of the town would be in darkness.

Lighting Contretemps.—A few days ago that part of the grands boulevards which is between the Place de l'Opera and the Place de la Madeleine, was plunged into partial obscurity by the extinction of the Popp regulators.

Electric Lighting at Reading.—The electric light was successfully installed in a portion of Messrs. Sutton and Sons' premises last week, the spacious flower seed room being lighted up with this illuminant by means of 60 incandescent lamps, some of 16 candle-power and others of 10 candle-power, the current for which is supplied from the Reading Electric Light Depôt, where a Thomson-Houston alternating current dynamo has lately been fixed.

The Bolton Corporation and the Electric Light.—This public body, in order to ascertain to what extent the electric light is required in the town, has sent out circulars inquiring from the large consumers of gas whether they were desirous of the change. Attached to the circular is this ominous clause:—The price of electricity will be 10d. per Board of Trade unit, equivalent to double the present price of gas in the town (3s. per 1,000 feet), exclusive of cost of all fittings, which would have to be borne by the consumer.

Electric Lighting in Harrogate.—We understand that the borough solicitor, Mr. Bateson, has received notice from the Board of Trade of the abandonment of the application by the National Electric Supply Company, Limited, for a provisional order for Harrogate, which was opposed by the Corporation.

Ship Lighting.—The Castle Mail Packets Company, Limited, is having three new large steamers built for the Cape service. The largest of these new vessels will excel in dimensions and speed any of the steamers now employed on the South African route and is expected to be ready in good time for next autumn's traffic. The steamer is lighted by electricity throughout, while all the public and sleeping rooms are connected with the steward's department, by an elaborate system of electric bells.

Asylum Lighting.—The lunatic asylum and colony at Vaucluse is lighted by electricity.

Telephony.—A Glasgow paper, in writing on the subject of the co-operative telephone movement in progress in Manchester and Glasgow, stated that it was proposed to adopt the Berthon telephones, as being the best at present available. Mr. A. D. Provand, of 9, Bridge Street, Westminster, corrects this assertion. The point has not yet been considered, nor will it come before those who are engaged in establishing co-operative telephony for several months yet. Mr. Provand has had many letters from America and from the Continent, as well as from our own manufacturers, offering instruments of various descriptions, but the selection of instruments is a matter not yet touched upon.

Exports.—The Board of Trade returns for February give the value of telegraphic wires and apparatus connected therewith during the month at £201,594, as compared with £14,051 and £32,086 in February 1888 and 1889, respectively. For the two months ending February the values are: £55,282 in 1888, £145,316 in 1889, and £273,280 in 1890.

Electrical Joke.—Electricity is evidently becoming popularised, as it is now forming the subject for jokes in the comic papers. The following is a specimen:—"Old Mr. Testy (*returning to his room after paying the hotel bill*): 'Don't touch me! I'm not sure about my insulation, and I've just been so heavily charged that I'm dangerous.'"

The Telephone in Russia.—Experiments have been recently made for the purpose of establishing telephonic communication between St. Petersburg and Moscow. The Goosdeff system was employed on the ordinary iron wire telegraph circuit, and it is reported that the experiments were in every way extremely satisfactory. The distance in a straight line between Moscow and St. Petersburg considerably exceeds 300 miles, and the successful employment of iron wire on such a long circuit is somewhat of a new departure.

The Dangers of the Telephone.—Two telephone operators at different stations in America got fooling around over the wires, and in fun proposed a marriage by telephone. A city justice performed the necessary ceremony, but without a licence. It has proved a serious thing, and eminent legal counsel say the marriage is legal and binding.

The Telephone in the United States.—There are at present about fifty telephone companies in the United States, the principal of which are the American Bell Telephone Company, the American Telegraph Company, and the Long Distance Company. The first mentioned company held up to 1887 the exclusive right to telephonic communication, and to-day it represents about one half of the capital engaged in this industry. Its lines, at the end of 1889, had a total length of about 107,367 miles. The total number of subscribers to telephone systems in the United States exceeds 200,000, and the daily communications passing over these systems are considerably more than a million.

International Telegraphic Conference.—The *Times* a few days since published a telegram stating that the Electric Congress, which was held last year in Berlin, would take place this year in Paris, and this was copied into several of our contemporaries. This statement was incorrect in its most important detail. It should have been announced that the International Telegraphic Congress would be held in Paris. This Congress, which embraces all the means for the transmission of speech and thought by electricity, does not meet yearly, but every five years. It did not meet in Germany last year, but it did five years since.

New Brazilian Cable.—It is rumoured that the Brazilian Government has decided to grant the concession for a direct submarine cable between Brazil and the United States to the amalgamated companies the Société Générale des Téléphones and the Société Française des Télégraphes Sousmarins.

Annual Inspection Tour of the Cornell Electrical Engineering Students.—For several years the students of the mechanical and electrical departments of Cornell University, America, have been in the habit of spending the week of the spring vacation in visiting the principal cities and inspecting the large plants of the manufacturing and electrical industries. The programmes for these trips are arranged under the direction of Prof. Robert H. Thurston, and through his influence many rare privileges are obtained for the students at the establishments visited. A large number of students annually avail themselves of these opportunities, the whole number being divided into parties of moderate size, each of which travels by its own route and is under the immediate supervision of one of the university professors.

Electric Tramcars for Glasgow.—A north country paper says:—A London electrical company having approached the directors of the Vale of Clyde Tramway Company with the view of obtaining permission to test electrical cars on their line, they have agreed to allow an experiment to be made on their Govan section, which is at present worked by cars propelled by steam. Arrangements for carrying out the experiment are in a forward state, and in a few days it is expected that a car having electricity as the motive power will be run for a brief period between Glasgow and Govan. It is claimed that electrical cars can be worked much more cheaply than those at present in use, and this, it is confidently anticipated, will be demonstrated in the forthcoming trial.

At a recent meeting of the Town Council it was decided not to interfere with the present arrangements of horse traction of the Tramways Company.

The London County Council Subways and Overhead Wires Bill.—No fewer than 36 petitioners have, within the time limited by the Standing Orders, deposited petitions in the Private Bill Office of the House of Commons praying to be heard in opposition to the passing of the Bill promoted by the London County Council for constructing subways for pipes and wires under the streets of the Metropolis, and for the creation of an efficient system of control over overhead wires and cables. Although this number of petitions is greater than any number that has yet been deposited against any English Bill now before Parliament, it does not fully represent the strength of the opposition which this Bill will have to encounter, inasmuch as the London water companies and a large majority of the electric light companies have consolidated their oppositions, and are represented by only two out of the 36 petitions lodged against the Bill. An analysis of the petitions shows that among the opponents are 13 railway companies, 10 local and other governing authorities, 5 gas companies, and 6 telephone, hydraulic and other companies.

Messrs. Verity's Smoking Concert.—The Cricket and Football Club in connection with the firm of Messrs. B. Verity and Sons, of Covent Garden, on Friday evening gave its third annual smoking concert at the Horseshoe Hotel, Mr. J. B. Verity being in the chair. The large room was crowded, there being between two and three hundred persons present. A select programme was gone through, and everyone expressed the opinion that it was an unqualified success.

Royal Institution.—The following are the lecture arrangements after Easter:—The Hon. George C. Brodrick, three lectures on the Place of Oxford University in English History; Mr. Louis Fagan, three lectures on the Art of Engraving; Mr. Andrew Lang, three lectures on the Natural History of Society; Prof. C. V. Boys, three lectures on the Heat of the Moon and Stars; Prof. Dewar, six lectures on Flame and Explosives; Captain Abney, three lectures on Colour and its Chemical Action; Dr. Charles Waldstein, three lectures on Excavating in Greece; the Rev. S. Baring-Gould, three lectures on the Ballad Music of the West of England (with musical illustrations). The Friday evening meetings will be resumed on April 19th, when a discourse will be given by Sir Frederick Bramwell, Bart., on Electric Welding; succeeding discourses will probably be given by Sir John Lubbock, Bart., M.P., Mr. W. H. Pollock, Mr. R. Brudenell Carter, Prof. Raphael Meldola, Prof. A. C. Haddon, Mr. A. A. Common, Prof. Boyd Dawkins, and other gentlemen.

Students' Meeting.—The students of the Institution of Electrical Engineers held a meeting last Friday, when Mr. H. Walker read a most interesting paper on "Ship Lighting," Mr. W. M. Mordey in the chair. A short discussion followed, in which the chairman, Messrs. Muir, Stephens, Poynton, Horn, and Cirlo took part. Mr. Walker having replied, a vote of thanks to the chairman terminated the proceedings. At the next meeting, to be held March 21st, Mr. R. Wrightman will read a paper on "Constant Current Regulators."

Mercier, Corlett & Co.—Mr. Maunsell Mercier, of Wigan, informs us that he has taken into partnership Mr. G. Stephen Corlett, A.M.I.E.E., who was for some years manager of Messrs. Sydney F. Walker and Olliver's business at Newcastle.

Magdebourg Lighting.—The Mayor is open, until May 1st, to tenders for the establishment of a central lighting and power station.

The Bermuda Cable.—We learn that the ss. *Westmeath* has been chartered by Messrs. Henley & Co., of North Woolwich, for the laying of the Halifax-Bermuda cable. Her dimensions are: Length, 320 feet; beam, 42·4 feet; depth, 28 feet; net tonnage, 2,095; gross tonnage, 3,191. She was built at Sunderland in 1882, and is now being docked in the Thames prior to being fitted with the necessary cable machinery.

Telephone Wires.—An interesting point in regard to the telephone system is to be raised in the House of Lords to-night. The Duke of Marlborough is to ask the Government what steps it is intended to take this session with regard to the appointment of a House of Lords' Committee to carry on further the investigations of the House of Commons' Committee of 1885 on the subject of telephonic wires and communications. He will, at the same time, enquire whether the Government have any intention, on the expiry of the English patents, of taking up the extension of the telephone system under the auspices of the Post Office, and if, in the event of the postal authorities not undertaking the work, the Government will give better facilities than have hitherto been obtainable to public companies.

Rochdale Refuses a Compromise.—The Chairman of the Gas Committee says that the lawyer of the Electric Lighting Company, who were anxious to obtain power to serve the inhabitants of Rochdale, has written to the Town Clerk to ascertain if there could not be some compromise come to with the Corporation, to prevent the company's scheme being opposed. He and the representative of the company met, and he found that the company were anxious to get a footing in the town, and he on the part of the Corporation was determined to keep the lighting of the town in their own hands, and no compromise was effected.

Acme Electric Works.—This firm has secured the order for making the numerous main and branch distributing switch and fuse boards required for the electric light extension at the General Post Office, also a large order for Cockburn's patent fuse boxes and fuses for use throughout the same installation.

The Institution of Electrical Engineers.—If the discussion on the papers of Messrs. Swinburne and Esson is completed when the members of the Institution meet on Thursday, the 20th inst., Messrs. H. Newman Lawrence and Dr. Arthur Harries will read a paper on "Alternate *v.* Continuous Currents in Relation to the Human Body." We can scarcely think that the authors will be able to add much to the scanty literature already existing on this subject, unless they have privately shocked to death a few volunteers who had submitted themselves to their treatment in the interests of science. However, it will be a change, and we hope it may prove worthy of an animated discussion.

The Frankfort Electrical Commission.—We have received a highly interesting and lengthy letter from Dr. Nordmann, of Berlin, who was an eye-witness of the experiments carried out by the Frankfort Commission, and which are now being described in our pages. This communication, which criticises the method adopted of comparing alternating with continuous current motors, will appear in our next.

Tinting Incandescent Lamp Bulbs.—The following recipe is due to Mr. Arthur S. Huey, of Minneapolis: —Prepare the glass by thoroughly washing in soap and water and drying. Then dip in bath (made by beating up the whites of two eggs in one and a half pounds or pints of water, and filtering) and hang up to dry. Dissolve the aniline colour in photographer's common collodion. Red or blue aniline will form clear solutions, while the green solution will require filtering. Yellow aniline forms a handsome colour, but the surface of the glass presents a frosted appearance after the application. Violet and purple colours may be obtained by combining red and blue in different quantities. When the solution is ready, dip the prepared glass bulbs therein, hang up to dry, and finally pass a current through the bulb for half an hour, that the heat thus generated may harden the coating of the collodion, or place in a current of air. The preparation can easily be removed with alcohol or sulphuric ether, but is not affected by water. Experience has shown that the best results are obtained by not using too much aniline. Make the colour light rather than deep, and apply two or three coats.

Lighting in Westphalia.—The Municipal Council of Cassel, in Germany, have just decided to introduce the electric light into that town. The streets will be lighted by electricity, also manufactories and dwelling houses, &c. In order to form some idea as to the size of the station or stations to be erected, the Mayor has issued a circular to the inhabitants asking for particulars as to the number of arc or glow lamps required. It is very probable that more than one central station will be required as Cassel is a large town, and the suburb Wilhelmshöhe will also take a share of the current. The first station will be in operation on the 1st October.

Claim for a Portable Electric Lamp.—Aron *v.* Watson.—(Before Mr. Registrar Wild.)—The plaintiffs, Messrs. Aron Brothers, Bridewell Place, sought to recover the sum of £7, the price of a portable electric lamp supplied to the defendants, Messrs. Watson Brothers, opticians, electrical engineers, &c., of 4, Pall Mall. Mr. Reed appeared for the plaintiffs, and Mr. George Kebbell for the defendants. Mr. Shape, the plaintiffs' traveller, said, that in December he called on the defendants, and saw one of them about the sale of one of the plaintiffs' lamps to them. He left a prospectus, and afterwards showed them a lamp. Some little discussion ensued between the two brothers, when one of them gave an order for a lamp. Mr. Reed said he understood it would be a question whether the lamp burned a certain number of hours. Mr. Kebbell: The question is whether it will burn at all. The witness said he examined the lamp, and found it in perfect condition. Mr. Kebbell: My defence is that the lamp would not act. Mr. Reed: The simplest plan is to light it. The Registrar: Are we to sit here for five hours to see if it will burn? Mr. Kebbell: The prospectus says five hours to eight. Mr. Reed said they were prepared to prove the lamp would burn for five to eight hours. Mr. Kebbell said the intensity of light was to be 25 candles. The lamp was returned as it had never burned for two hours, and the light was very bad during that time. The plaintiffs' traveller said he offered to give the defendants every possible assistance to show them that the lamp would run the time he alleged. They would not, however, allow him to do anything to it at all. The lamp was returned by the defendants in a defective condition. One of the poles had been knocked off. It was not possible for the lamp to burn without it. In cross-examination, he said he offered to test the lamp. He was not now in the plaintiffs' employment. He did not claim commission on this order. He told the defendants the lamp was the best thing in the world, which was true. Mr. Aron, one of the plaintiffs, said he guaranteed the lamp. He had been burning them since October. They always burned from five to eight hours, and he had seen some burn ten hours, but they were never less than five. He had never had any complaints before. Mr. Kebbell said his case was that the plaintiffs' traveller was anxious for the defendants to buy a lamp, and he recommended it as the best thing out. The defendants instead of that found it would not go, and sent it back. Mr. A. H. Watson said he was an electrical engineer, and therefore acquainted with these lamps. He had a lot to do with the many different kinds of lamps, but he had not seen this one until the traveller called his attention to it. The traveller said it would burn for five hours. He was particular in asking that question, as many of these lamps would not do that which was stated of them. When the lamp came he carried out the instructions contained in the prospectus. The light they obtained was certainly not 25 candle-power, as represented. An hour after the light had been burning it perceptibly diminished, and at an hour and-a-half it was practically no use as a light. There was a red glow in the light, but it did not illuminate. He did not refuse to let the plaintiffs' traveller test the light. On the contrary, he said he would accept any suggestions, as he had wasted several hours on the lamp. The lamp was not damaged when he sent it back. The registrar said he must find for the defendants with costs. If the defendants, who knew something about electric lamps, could not make it work, how could the public be expected to do so?

A Telegraphic Competition in New York.—It is announced that on the 10th prox. a telegraphic competition for both sexes will be opened in New York, those entering having to compete in speed trials in reading and transmission. Mr. Edison will be the judge in this not uncommon affair, in which valuable prizes are offered to the winners by the telegraph companies, newspapers, and private firms.

Fire Risk Rules Probably Ignored.—Shortly after eight o'clock on Tuesday night, last week, an outbreak of fire occurred in the premises of Messrs. R. and W. Sorley, jewellers and silversmiths, at the corner of Buchanan and Argyle Streets, Glasgow. The fire was extinguished before it had taken any hold upon the building, and the damage done was comparatively small, but the occurrence is worth noting. The premises are lit by electricity, and the origin of the outbreak is believed to have been an insufficiently insulated wire coming in contact with and melting one of the gas pipes, the ignition of the gas following. In helping to extinguish the fire one of the firemen stepped on a metal grating in the pavement and received a shock which threw him down. A policeman in attendance also received a severe shock through touching or stepping on some of the pipes or ironwork of the building.

Indian Telegraphs.—From the last Administration report of the Indian Telegraph Department it appears that the lines at work now extend over 33,000 miles, representing 100,000 miles of wire. The net profit last year was nearly 4½ per cent. During the same period 60,000 telegraphic money order remittances were made, indicating that, in this respect at least, India is in advance of several European countries, including "Home." During the Sikkem war a telegraph office was opened at an altitude of 13,000 feet, then supposed to be the highest telegraph office in the world. Much of the work is carried on under trying circumstances for the staff, and stoppages have had frequently to be reported as due to the illness of signallers, whose lines are cast in unhealthy and out-of-the-way districts. The Indo-Siam line, which communicates overland with Burma, Siam, and Cochin China, is apparently the one most liable to interruptions. The Dacoits have a nasty habit of cutting the wires, and in disturbed districts and during heavy rains the repairing parties have by no means an easy time. The felling of trees in jungles traversed by the wires is another and fruitful source of interruption. When the not very extensive gap which divides the Chaman terminus from the Russian lines has been wired over, the overland communication with Europe will be complete.

The Motor to the Rescue.—An illustration of the adaptability of the electric motor was recently afforded in Chicago. The engine and boiler of a printing company had been wrecked by an explosion. Had they been obliged to wait until the new boilers could be set up and got ready, and the engine overhauled and repaired, it would have caused a delay of a month, and the loss in failing to fill contracts on time, and the loss to *employés* by being thrown out of work, would have been greater in money value than the loss caused by the wreckage. The situation was promptly realised, and a 40 horse-power electric motor was placed in the building and connected with the shafting, and the next morning the office was in full work. Instead of a month's delay, one day had been sufficient to make the necessary change.

NEW COMPANIES REGISTERED.

MacMahon's Patent Electric Check System, Limited.—Capital, £30,000 in £10 shares. Objects: To adopt an unregistered agreement, of 6th inst., between Francis Edward MacMahon and Charles Hitchen Ashley of one part, and Wm. Barton of the other part. To manufacture automatic and other machines, instruments and apparatus of all kinds, for measuring, checking, recording or registering the supply of liquids and other articles. Signatories (with 1 share each): A. Harrow, 87, Corbyn Street, N.; T. Ball, Kingston-on-Thames; A. L. Sims, 3, Embleton Street, Lewisham; J. Kemp, 9, Springfield Villa, Bowes Park; *Hy. Burt, Fetter Lane; Percy Squire, Station Road, Finchley; Wm. Ramsey, 29, Farringdon Street. The first directors are Charles Hitchen Ashley, Hy. Burt and Francis MacMahon; qualification, £1,000 in shares or stock; remuneration, divisible sum equal to £100 per annum in respect of each director. Registered 6th inst., by Gush Phillips & Co., 3, Finsbury Circus.

Keys's Electric Company, Limited.—Capital, £15,600 divided into 3,000 ordinary shares of £5 each, and 600 founders' shares of £1 each. Objects: To carry on the business of electrical and mechanical engineers and manufacturers, and of wholesale and retail dealers in electrical apparatus, and also of contractors for the supply of electricity for any purpose whatever. 1,500 of the ordinary shares are to be allotted upon application to J. H. Ward, of 22, Lower Phillimore Place, W., or his nominees; and the remaining ordinary shares to Franz Deutsch, of Warnford Court, Throgmorton Street, or his nominees. Signatories: J. H. Ward and F. Deutsch, 198 shares each; J. W. Keys (electrical engineer), 42, Lambeth Road, S.E., 50 shares; A. A. Blake, 29, Aldred Road, Kennington; T. Lane, 10, Ennis Road, Finsbury Park; R. Hall, 54, Norfolk Road, Dalston; E. T. Hamilton, 59, Sutherland Square, Walworth Road, 1 share each. Messrs. Ward and Deutsch are each to appoint a director. Registered 7th inst., by Tamplin Taylor and Joseph, 165, Fenchurch Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrician Printing and Publishing Company, Limited.—The office of this company, formerly at 1, Salisbury Court, is now situate at 2 and 3, Salisbury Court, Fleet Street.

CITY NOTES, REPORTS, MEETINGS, &c.

The Gulcher (New) Electric Light and Power Company, Limited.

The following prospectus has been issued:—

"Capital of £70,000, in 70,000 shares, of £1 each, of which 50,000 are preference shares, and 20,000 are deferred shares. Issue of 37,723 10 per cent. preference shares of £1 each.

"The deferred shares are not entitled to any dividend until £10 per cent. has been paid to the preference shareholders, after which any surplus available for dividend is to be rateably divided between the preference and deferred shareholders.

"The preference shares are also entitled to priority in respect of capital, in the event of any sale or liquidation of the company's assets.

"The whole of the deferred shares have been allotted, and £12,277 of the preference capital has been issued. It is now proposed to issue the remaining £37,723 of £10 per cent. preference capital of which a considerable proportion has already been applied for by the directors and their friends.

"The whole share capital and assets of the company are subject to £8,000 £6 per centum first mortgage debentures repayable in 1987.

"The Gulcher Electric Light and Power Company, Limited, since 1887 the Gulcher (New) Electric Light and Power Company, Limited, is one of the few electric lighting companies of the many formed in 1882 which has survived to the present day.

"It has a sound and increasing business; admirable plant and machinery; and (what is of the first importance in electrical matters) an experienced and skilled staff of officers and workmen.

"Its dynamos and other manufactures are of the very latest type; are among the few that have been accepted by the Admiralty Department of H.M. Government; and are second to none in the market.

"The company has erected some of the largest and most important electrical installations in this country, notably those at the Crystal Palace, Sydenham; the steelworks of Sir William Armstrong, Mitchell & Co., Limited, at Elswick; and the magnificent recently erected workshops of Messrs. Arthur & Co., Limited, of Leeds.

"The company has also during the past year completed the public lighting of the city of Wellington, New Zealand, with the greatest success. It has wired the whole city with cable sufficient to meet the private demand for electricity, and arrangements are

at present being made for supplying the light to private consumers.

"The share capital of the re-constructed company soon proved insufficient for such work as has been thrown upon it of late, and in addition to £8,000 of permanent debentures bearing interest at £6 per cent. per annum, the company has issued and employed during the last two years £16,000 of subsidiary debentures bearing interest at £10 per cent. per annum.

"The result of the passing of the Electric Lighting Act, 1888, and the consequent revival of electrical enterprise, is that the work offered to the electrical engineering companies (especially to those which have been established for any length of time), is already more than they can undertake, and it must be multiplied tenfold in the course of the next few months, when the various electricity supply companies all over the kingdom have obtained the provisional orders for which they are now applying. Electrical engineering is a business which it takes a long time to learn, and old established companies will now reap the benefit of the experience of the past seven years, and its trained and educated staff of employés is one of the advantages which this company possesses.

"It is to enable the company to undertake existing offers of business, and to participate in the large amount of work now coming forward, that the directors have resolved to issue the balance of the preference capital of the company.

"It is proposed out of the £37,500 now asked for, to pay off the £16,000 of £10 per cent. debentures. This will give an additional working capital of £21,500, of which it is intended to leave about £13,000 uncalled to meet future contingencies.

"Careful estimates have been prepared, which show that after providing for the interest on the £8,000 of permanent debentures, and allowing for depreciation and the cost of carrying on the company, the work in prospect ought to enable the directors to declare dividends of £10 per cent. upon the preference capital of the company.

"An agreement, dated 23rd February, 1888, was made and signed between Daniel de Castro, liquidator of the Gulcher Electric Light and Power Company, Limited, of the one part, and F. Legg, as a trustee for the Gulcher (New) Electric Light and Power Company, Limited, of the other part.

"Numerous contracts have been entered into by the company since its formation in 1888. It is doubtful, under the circumstances, whether the provisions of Section 38 of the Companies' Act of 1867 apply to all such contracts, but in order to avoid all questions as to what is required to be stated under the aforesaid sections, subscribers will be deemed to have had notice, and to have waived all rights to further particulars of such contracts, whether under that section or otherwise.

"The memorandum and articles of association of the company can be seen at the company's offices, Battersea Foundry, S.W. A copy of the said agreement can also be seen at the same place.

"*6th March*, 1890."

Liverpool Electric Supply Company.

THE annual meeting of this company was held on Friday last at their new premises in Highfield Street, Mr. A. H. Holme in the chair.

The report states:—"The amount of net profit available for dividend, including the balance brought forward from last year, is £2,750 13s. 7d. Out of this sum the directors recommend the payment of a dividend of 3 per cent., absorbing £21,000, and to carry forward the balance to next year's account. The expenditure on capital account during the year (including a proportionate charge for general expenses) has been £52,957. For a business of this class it is obvious that the capital expended on land, buildings, and plant must, in the early stages, be temporarily out of proportion to the possible earnings of the company, as it is necessary to construct the generating stations, and to lay the underground mains on a sufficiently ample scale to meet not only the present but the future demand for the light. For example, the number of incandescent lamps on December 31st, 1889, supplied from the company's stations was approximately 6,400, whereas the mains, stations, and plant were capable of supplying double that number. During the year the balance of the company's share capital has been issued at a premium of 5 per cent. After protracted negotiations with the local authority, the directors have succeeded in obtaining a provisional order for an enlarged area of supply, including Bold Street and other important streets which were not included in the original Board of Trade license. The position of the company is very much improved by the provisional order, which places its business on a thoroughly satisfactory and permanent basis. The demand for electric light steadily increases."

The Chairman, in moving the adoption of the report, congratulated the shareholders on the result of the year's working. Although the dividend declared was small, it had been well earned. Fresh arrangements have lately been made with Messrs. Holmes and Vaudrey. By this arrangement the company secured the services entirely of the former gentleman, while Mr. Vaudrey would give his valuable experience in case Mr. Holmes was ill or not able to attend to his duties. This alteration did not cause any pecuniary difference to the company. With regard to the safety of the electric light, he stated that the deaths which had recently occurred in the United States were owing to the fact that the wires were overhead. This was different in Lancashire; with few exceptions all were underground, and the increased demand for the light was much in excess of the most sanguine anticipations. Indeed, few companies had come so prominently into public favour as this; hence it was natural to expect competition; but they had completed improvements by which they were enabled to defy competition, with due regard to material and workmanship.

Sir David Radcliffe seconded the adoption of the report, which was supported by Mr. James Lister and Mr. Davidson, and carried.

The retiring directors, Sir David Radcliffe, J.P., and Mr. Vaudrey, were re-elected, with Mr. W. L. Jackson as auditor.

The Institute of Medical Electricity, Limited.—An extraordinary or special general meeting of the above-named company will be held at the registered office of the company, No. 24A, Regent Street, Waterloo Place, London, S.W., on Monday, the 17th day of March, 1890, at 4.15 o'clock in the afternoon, for the following purposes, viz.:—To receive a statement from the directors setting forth that the applications for preference shares have not come up to the minimum agreed upon, and to consider whether the company shall in consequence be wound up, or what other course shall be adopted.

Brazilian Submarine Telegraph Company, Limited.—The directors on Wednesday declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended December 31st, 1889, and payable on the 25th inst. The books of the company will be closed from the 18th to the 24th inst., both days inclusive.

Direct Spanish Telegraph Company, Limited.—In their half-yearly report the board of the Direct Spanish Telegraph Company, Limited, propose a dividend at the rate of 6 per cent. per annum, carrying forward a sum of £846, after adding £2,500 to reserve.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 7th, 1890, amounted to £5,060.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 7th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,896.

LEGAL.

A Question of Meters.—An action was brought by Messrs. Chamberlain and Hookham, 4, New Bartholomew Street, electrical engineers, against the Cadogan Electric Light Company, 91, Manor Street, Chelsea, to recover £31 10s., the price of two meters for measuring electric current. Mr. Hugo Young (instructed by Messrs. Smith, Pinsent and Co.) appeared for the plaintiffs, and Mr. Ruegg (instructed by Messrs. Webb and Co., London) for the defence. The defendants supply the electric light to houses in Cadogan Square, London, and that neighbourhood, and in June last year they wanted a meter to measure the current supplied to their customers, and they applied to the plaintiffs, whose circular they had received. It was represented that Hookham's meter was a reliable one, and ultimately two were ordered. The meters did not work properly, and the cause of the alleged failure was that the mercury contacts which conveyed the current to the armature got corroded through standing, and the machines could not act. The plaintiffs claimed the price of the meters on the ground that they were of their usual make, and were sent in good working order, but were not warranted. The defence was that the meters were warranted, and that there had been a breach of warranty. His Honour gave a verdict for the plaintiffs.

Action Against the Great Western Railway Company.—At Torquay County Court, on Saturday, before Judge Edge, Mr. William Radcliff, electrician, Torquay, sued the Great Western Railway Company for 10s., damage caused to Edison-Swan incandescent lamps in transit from London to Torquay. Mr. Lambert, solicitor, Paddington, appeared for the company, and Mr. Radcliff conducted his own case. He stated that, when he opened the box containing six lamps, he found the filaments of two broken. A special glass rate had been charged in order to secure safe transit. He attributed the breakage of the filament to jolting. Evidence as to the proper delivery of the box of lamps to the Great Western Railway office in London was given by William Gritt, packer to the Electrical Supply Company. Mr. Lambert, in defence, contended that the lamp in question was a defective one, and that the fact that the glass was not broken showed there had been no negligence on the part of the railway company. There was also nothing on the outside of the box to indicate the fragile nature of its contents. Alfred Henry Watson, who has sole control of electric light plant at the Great Western Railway station at Paddington, where the Edison-Swan lamps are used, said about one out of ever 300 was broken. If a lamp was found with a broken filament, it was returned to the company. They frequently had lamps in which the filament was broken and not the glass. He had dropped a good many lamps himself, but the filament remained unbroken. In the lamp in question he considered that the carbon had been broken in jointing. Radcliff maintained that a sudden jolt would break the filament without breaking the glass. After laying stress on the absence of any notification as to the contents of the box, his Honour non-suited the plaintiff.

REMARKS UPON DRY BATTERIES.*

By JOHN A. BARRETT.

DURING a recent study of the open circuit battery problem, more particularly in that class of cells suitable for telephone service, I have incidentally made some observations upon the constitution and value of so-called "dry" forms of battery, as compared with those in which the solution is in the state of a free fluid.

I find, so far as my inspection has gone, that "dry" batteries involve nothing essentially new in the principles of voltaic action, Volta's own "pile" being a complete type of the distinguishing features of these devices. In fact, "dry" batteries do not to-day present any originality in electrolytic chemistry, but merely store away the water of solution in more or less complete mechanical suspension by means of some inert absorbent material. Substantially the same chemical processes are relied upon, and, in the main, identically the same chemical materials are employed as in batteries not "dry." Also, the water of solution is always present with its peculiar and essential functions to perform, though by reason of the inactive solids with which the spaces of the battery are packed, the amount of water contained in a cell of given dimensions is very considerably diminished.

The office of water in primary batteries is two-fold; first, it is to dissolve and hold in an operative state the chemicals by which the voltaic action of the cell is excited and continued; and second, it is to dissolve and diffuse the chemical products resulting from that action. It is evident from this that the amount of water which any type of battery is capable of holding bears a direct relation to the amount of work which a fixed size of that particular battery is capable of yielding.

The relations of these propositions to the "dry" battery question will appear from an application to the case of zinc-carbon sal-ammoniac batteries. I have concluded, from a long experience with almost every conceivable form of this class of batteries, that the amount of water which any cell will contain stands almost alone and nearly independent of the size and form of the electrodes as the limiting measure of the ultimate life of the battery at any work for which it is fitted. The size and form and quality of the electrodes affect the temporary constancy of the cell, but the question whether, in any specified service for which the cell is adapted, it will continue active for one month, or six months, or a year, is answered almost exclusively by the measured quantity of water which the cell is made to contain. In all these batteries it is the loss of sal-ammoniac and the accumulation of zinc oxides and ammonio-compounds which determines the final failure of battery action; and consequently the displacement of the available water of solution in any degree by absorbent solids will proportionately shorten the active life of the cell.

I do not speak of the impediment which the absorbent packing offers to the desirable diffusion and equalisation of the soluble products in such cells, for, compared with the importance of the amount of water present for promoting the solubility of these products, the free circulation of the fluid is only a secondary consideration.

The value of an abundance of water in batteries will be still further emphasised by a statement of fact concerning the Leclanché battery. In this cell, so widely used in telephone and domestic work, the serviceable life of the negative element is commonly supposed to be fixed by the amount of binoxide of manganese associated with the carbon conducting plate; but it is susceptible of ready demonstration that long before the active oxygen of the manganese is exhausted, the element is declared used up and is customarily thrown out as worthless. The cause of this failure of the element is chiefly the accumulation in the porous cup and among the manganese of compounds of zinc which are insoluble in the scanty and impoverished fluid.

The result of this condition is not so much a loss of electromotive force as an increase of internal resistance of the cell. Such a clogged-up element may be made fit for a renewed term of work by judicious treatment to a washing in dilute muriatic acid, and by setting up again with a fresh charge of sal-ammoniac; or the resuscitation may be partially secured without the washing by supplying the battery with a new and strong solution of sal-ammoniac, to which it is well to add a little muriatic acid.

But the clogging up of the element and the period of its activity would have been in the first instance postponed, if the element had been used in a larger jar with more water containing more sal-ammoniac. And conversely, the first life of the element would have been shortened by the employment of absorbent material, and the consequent displacement of a part of the water of solution.

A distinction should be recognised between the constancy of electromotive force under temporary test, and the duration of the period over which the cell will perform a specified amount of work. The packing of the cell with inert matter to the exclusion of a portion of the water, does not necessarily weaken its electromotive force, especially during the early stages of its service; but by so much as the water is displaced, the time is hastened when the original excitants of the battery lose their energy and are supplanted by the deleterious products of chemical action.

What is here stated of zinc-carbon sal-ammoniac batteries is equally true of all types of cells in which the impoverishment of the battery in service is attributable to the accumulation of undissolved products. Those batteries in which chromic salts are employed will evidently do more and better work with a free fluid than if the chemicals are incompletely supplied with water. In fact, the principle is of pretty general application to all open circuit batteries. On the basis of electrical measurement, therefore, it may be held that in efficiency and economy the fluid batteries are very considerably superior to the "dry."

There is furthermore one chief mechanical feature which I will mention as advantageous to the fluid batteries, and this is, the readiness with which the parts of the battery may be separated and any one part replaced by new, without the necessity of casting away or destroying other unconsumed portions of the battery. A provision for this is lacking in most "dry" batteries, and when from any cause the cell becomes unserviceable, although the failure or defect may pertain only to a single element of the cell, the whole must be cast out and lost altogether.

I have so far put the case strongly in favour of fluid batteries. There are evident advantages in "dry" batteries, and these advantages have led consumers to desire, and manufacturers to produce them. I have endeavoured to show how the advantage has been gained at the essential loss of economy and efficiency; and this for the purpose of leading each consumer of batteries up to a consideration of where the balance lies between the gain and the loss in the selection of batteries for his particular uses, and to a more careful discrimination regarding the somewhat plausible characteristics of "dry" batteries.

With respect to "dry" batteries, there is, first, a certain kind of service for which their superior fitness is unquestioned. For portable purposes, either as testing batteries or for medical uses, on ship board or on railway cars, or, in general, in any situation where the battery is subject to movement and agitation, free fluid in the cells may be regarded as so troublesome and unsatisfactory as to leave it mainly an alternative of "dry" batteries or nothing. Beyond this, there are other uses which I can distinguish as rising superior to questions of efficiency and economy; for instance, in connection with bell ringing and domestic outfits to be sent into remote places, and to be set up and cared for by persons unskilled and liable to become confused in the details of fluid batteries, "dry" cells all ready for service, requiring only the attachment of two wires, would strongly recommend themselves. Similarly in the telephone field "dry" cells are desirable for use in the smaller country exchanges and isolated places, where the inspection and care of apparatus is necessarily left to those to whom the proper handling of fluid batteries might constitute a difficulty.

But there remains the great extent of uses in which open circuit batteries are employed, requiring the exercise of both experience and judgment in choosing between the convenience of "dry" batteries and the greater efficiency and economy of the fluid batteries. The superior simplicity and convenience of "dry" batteries for storing, handling, transporting, and placing in service are acknowledged. The superior economy and efficiency of fluid cells when once applied to any specified service should, in my opinion, be also acknowledged.

And so the selection in any case between the two should be determined by the consideration of whether the gain by convenience in the manipulation of the "dry" battery is equal to, or greater than, the loss by reason of its diminished capacity for work; always holding confidently the maxim that, excepting where mechanical conditions require the contrary, every "dry" cell, when once in service, would be much improved if it could be converted into a fluid cell.

I do not regard it as too emphatic a proposition to say, in conclusion, that so long as "dry" batteries are essentially nothing but modifications of fluid batteries with an insufficient supply of water, experience will demonstrate that the field of their usefulness is rather narrow and specialised.

* *Electrical World.*

SAFETY AND SAFETY DEVICES IN ELECTRIC INSTALLATIONS.*

THE development of the electrical arts, particularly in the direction of lighting and motive power transmission, has, in the past few years, been very great. It has brought with it a demand for very much work of a novel character, as regards the details of plant and methods of installation. It has also entailed, in many cases, elements of risk to life, and danger of fire. How far these risks have been, or can be, removed by proper attention to details and care in installation, has become an important subject for discussion. How far such risks have been increased by reckless installation of conductors, by faulty materials and supervision, is not easy to determine. There can be no doubt, however, that electricity, as an agent, in itself is not to be charged with bringing about the results for which recklessness in its use is sufficient to account. That under favourable conditions for discharge through a person's body, electric currents of comparatively high pressure may injure or kill, is not to be questioned for a moment. I have no sympathy with any effort tending to impress a false estimate of such risks, or tending to give the impression that they are absent, when in reality they are existent. I have no sympathy with any efforts to exaggerate such risks, efforts which have not been wanting, indeed, as is well known. The fire risk, as well as the personal risk, involved in electrical

* Read by Prof. Elihu Thomson at the National Electric Light Convention, Kansas City, 1890.

work is present in a greater or less degree, in accordance with the perfection of the work of installation and maintenance, the provision of the proper safeguards, and selection of the best conditions.

These are matters which are, every day, of growing importance in all the electric industries, not even excepting telephonic systems and other such work, which, if badly arranged and not properly maintained, may cause crosses due to falling wires, &c., to become sources of danger, trouble and annoyance in the distribution of lighting or other currents. There is one fact which is of the greatest importance in this connection, and it is that safe installation means, also, good service. There can be no question that the risk to life *from shocks*, even with bad work, would be removed by not using high potential currents, as they are called, either alternating or direct. There can be no question, also, that a shock obtained from certain characters of current, such as an alternating current, is much less safe than in the case of continuous currents of equivalent pressures. Nevertheless, I am just as firmly convinced that the fire risk is very much less with alternating than with continuous currents of equivalent potential, assuming the work of installation equally good. The fact that it is difficult to sustain an arc, or rather that it is easy to select conditions which will prevent arcs forming with the alternating system, as compared with the continuous current system of much less potential, is greatly in favour of the former. Hence switches, fuses, bad joints, ruptured wires, are much less liable to arc and incur risk of fire with alternating than with continuous currents. Would it be possible to work successfully, using only low potential currents of either character? Would we be able to utilise water powers for lighting, without employing pressure of potential sufficient to convey the energy to a distance over a conductor of moderate or non-prohibitive cost? In most cases we would certainly not be so able. Again, to utilise water frontage for cheap coal supply, and to employ compound condensing engines, to insure small running expenses by massing the machinery at one station, to make use of railroad facilities, &c., in short, to work under the most advantageous operative and economical conditions, we *must* convey electrical energy by moderately high electric pressures, so as to avoid prohibitive losses or prohibitive cost of conducting wires. If ever our great natural resources in water powers are to be developed and utilised, it will be by the employment of comparatively great electric pressures for conveyance of energy to distant points. If great saving of cost of fuel and other expenses in operating one large steam plant, instead of a number of separate plants, with their attendant risks, in large cities, is an object worth seeking, it will be found in the conveyance of electric energy at fairly high pressures. It must not be forgotten in this connection that even with very low pressure currents, safety from fire risk is only to be secured by careful construction and supervision, and that risk of fire often involves personal risk. Subway and underground conductors have caused manhole explosions, with both low and high potential currents. Such accidents are generally explained by accumulations of coal gas formed in the manhole and subsequently fired by the electric arc or spark of a leak. This may be, and probably is, sufficient explanation, but another may be given—the evidence of the possible correctness of which I have witnessed. A heavy leak or overheating occuring at some point of the conductors near the manhole may generate directly a large volume of imflammable gas from the distillation of asphaltum or other substance used as an insulator, and this gas, mixing with the air of the manhole, may be easily fired by the heat of an arc or spark subsequently to its production, and cause a violent explosion. The remedy is thorough and continuous ventilation of the spaces in the manhole and subway. An instance of a storage battery car being wrecked, from a similar cause, is on record. In this case the battery conductors were probably overheated by a short circuit, and filled the compartment in which the batteries were with inflammable gases, and the further heating fired the mixture, the result being a violent explosion which greatly damaged the car. Such accidents always involve personal risks, and are to be prevented by simple means properly applied.

But the popular mind is so used to gas explosions that the newspapers have only a few lines to devote to them, while an accident in which an electric shock is obtained, although it has taken place through disregard of some simple precaution, is more than likely to be copiously provided with head lines and harrowing details. I even find one of the journals, whose name states its scientific character, attributing both the Lynn and Boston fires to electric wires. There is on exhibition at Lynn, as a curiosity, the oil stove which caused the fire, and inquiry into the cause of the Boston fire has, so far as I can learn, rather tended to discredit the theory than to confirm it. Notwithstanding these facts, it is true that under faulty conditions of lines or plant fires may arise, and hitherto have arisen, traceable directly to the heating effects of electric currents. Perhaps if the accidents which happen serve to enforce the fact that the best work, the most thorough provision for emergencies, and careful consideration of details of electric work will be requisite to secure proper safety in the electrical field, as in other classes of work, their mission will be fulfilled. Severe and inconsiderate as has been the dealing with the wire question by the authorities in New York City, yet it cannot be denied that the condition of the overhead circuits there had been in the past few years going from very bad to much worse. In many cases considerations of safe working would seem to have been neglected in the competition for business. The lines of four or five different companies competing in the same territory might be found, the result of this condition being, without doubt, to enormously increase the risks. There have been hints of the coupling-up of dynamos in series, and so increasing the potential of lines already worked at too high pressures in relation to their condition of insulation, and to the placing of the lamps or other work supplied from such lines. Along with this we find the air full of telephone, telegraph and signal wires of various sorts, none too secure from rusting out or breaking. Many of these latter wires could, no doubt, be easily buried underground, with advantage to the service, but it is certain that to attempt to bury the electric light wires in a hasty, ill-considered fashion, merely for the sake of getting rid of overhead lines, would be productive of no good results, either in avoiding risks or bettering the service. The placing underground of very many of the wires now found overhead in our large cities is, in my opinion, a matter which must come in time, but it should be done carefully and gradually, so as to secure the best work. Meanwhile the reorganisation of existing wires, the removal of unused wires or redundant wires, as where two systems or circuits in the same territory overlap while serving substantially the same purpose of supply, and the use of first-class insulation on the wires would go far to securing safe working and uniformly good service. Besides all these precautions, and outside of them, wherever the conditions are and have been favourable to safe installation of overhead or underground circuits, there are to be found a class of appliances which are called "safety devices," inasmuch as it is their purpose to provide for abnormal conditions and remove risks which, with perfect working and maintenance, are usually absent, but may be brought into existence by accident or unforeseen defects. Such risks may be by outside interference with lines, or by lightning, by falling of poorly-constructed signal and other wires upon overhead wires, by unusual wind or sleet storms, by failures of all kinds, as in the working of lamps, switches, &c. It is here that the safety device is found to be useful. Such devices are to the electrical systems what check valves, overflows, traps, and safety valves are to hydraulic systems. There is, of course, no room for doubt that if the insulation of all parts of the plant, as dynamos, lines, lamps, &c., were maintained always at its best, and if the mechanical strength of lines, hangers, poles, &c., could be always relied upon, and further, if the effects of lightning induction were never present, there would be but little use for any purely electrical safety appliances, such as those for guarding against leaks and diversions of current. To expect such perfection of conditions is to expect too much. A rigid system of frequent testing can, however, go far to anticipate and to discover the departures from such safe conditions, and enable the disturbing conditions to be removed. Nevertheless, there will always remain opportunity for unskilled or careless handling so altering the condition as to provoke trouble; there will always remain chances of undiscovered defects, chances of interference from outside. The effects of lightning are an important factor during the thunderstorm season. I am driven to conclude, therefore, that safety devices are, and will continue to be, important factors in electric work. The more thoroughly they are adapted to their intended functions, the greater the security, and the more extended their application. That system of distribution will surely survive, which, while involving economy of first cost and maintenance, at the same time secures the greater safety and embodies the greatest flexibility. I assume, of course, that the running economy is practically good in every case.

In the very early days of arc lighting, with a single lamp only on a circuit, the idea of safety from fire or shock did not present itself. When such lamps begun to be run in a series of eight or ten, or more, the need of an efficient cut-out was felt, so that a defective lamp failing to feed its carbons should not burn with a long arc or flame, and so involve risk or fire, or extinguish the other lights. This need was met in 1876 by Lontin, who used the shunt circuit to actuate a shunting switch around the defective lamp. The Brush cut-out followed, and was a decided improvement on Lontin. Fuller and others early went over the same ground. The film cut-out, or shunting switch, depending on a small thickness of a high resistance insulator, such as oiled paper, to prevent its closure, which paper film is overcome by the difference of potential or pressure between the carbons when a long arc forms, was brought out by the writer, and later, the "vacuum cut-out," a modification which rendered the device self-setting for repeated action if needed. It is scarcely necessary to add that spark-catchers and enclosing globes with wire nettings were early additions to arc lamps to prevent sparks reaching inflammable material near by, and the globe also in addition served to diffuse the light. Current regulators were additions to arc machines, and acted to prevent undue current, and secure thereby not only safety but good service. The fact that good service in most cases is assisted by appliances which ensure the safety, or is even dependent on them, is a fact which ought not to be lost sight of in connection with the general subject of electric installation.

The early installations for arc light in and out of buildings were made with bare wire circuits, and it is a satisfaction to me to recall in these days of forgetfulness of the benefits conferred by electric industries, and exaggeration of the dangers of properly installed plants, a case which occurred in connection with one of the earliest commercial plants of the Thomson-Houston arc lights in 1879. The machine, of about eight or nine lights capacity, with bare wire lines, was put up in a large brewery in Philadelphia, two arc lights lighting the stables in which were 30 or more valuable horses. One evening a fire started in the hay lofts in the story above, and where there were no lights of any kind used, and soon the flame and smoke spread to the stable room and menaced

the horses. The proprietor happened to think to start up the electric lights at this juncture. Their brilliant rays saved the animals, which were removed without trouble, and the lights were kept burning during the progress of the fire. Its spread was limited by the efficient work of the fire department. The arc lamp globes were at times full of water, but, to the surprise of the firemen, the lights were not extinguished, but assisted them in their efforts very materially.

As the number of arc lights placed in the circuit grew, the necessity for thorough insulation was appreciated; the effort to secure which, for arc lighting lines, has resulted in very great improvements being made in the past two years. So far as electric wires go the best "safety device" is a perfect insulation. In order that this matter shall not assume the condition of a trial of strength between armour and armour-piercing, as in naval affairs, with a constant growth of both, the advantage always being on the side of armour piercing or insulation-piercing, I think that efforts to run more than a certain limited number of arc lights in series should be discouraged. Eighty or one hundred lights, or even more, have been run, and could doubtless be run safely under favourable conditions, but I doubt that such conditions can be found in city work; the interfering actions are too numerous, while the maintenance of good conditions would be too expensive. Without such good conditions, there would be grave dangers involved.

It has become a practice to use incandescent lamps of low resistance in series on arc light circuits or other constant current lines and much useful work is so accomplished. Here, again, safety from fire risk depends on certain safety devices, the most important of which is the shunt-forming device, when the carbon lamp conductor breaks. A number of very simple and effective devices are employed for this shunting action. Without such devices the tendency to arcing would be very great. It is advisable, also, not to rely on any one device alone for this purpose, especially if the lights are used indoors. Here the film cut-outs may supplement the action of a shunting device operated by the heat of an arc set up when the lamp carbon becomes discontinuous. These latter are the fusing cut-outs, twisted wire cut-outs, and others which connect the lamp wires together in the lamp, and so form a complete shunt. Other forms exist, notably the third wire cut-out, acting by diversion of current from the arc to a third or intermediate wire between the lamp conductors.

As is the case of the other devices mentioned, the perfection of operation of one, or a combination of several of these shunting contrivances, conduces not only to uniform service but to absence of risk. Absolute cut-off switches are now in common, if not in universal, use to cut-out loops of serious circuits, and in a measure may therefore be regarded as safety devices, but not of an automatic character. Outside of these factors just mentioned, safety in such circuits rests in insulation and maintenance, avoidance of leaks, or crosses, proper placing of wires and lamps, avoidance of partial contacts or partial ruptures of the circuit at joints, binding posts or switches. In series circuits the main object is to avoid a concentration of, or establishment of, large differences of potential at points in the line where the currents find or can find a path; in low potential, multiple arc systems as used in direct incandescent work, the object is to avoid concentration of current at points where such current cannot find a sufficiently low resistance path. Hence there are required cut-offs for an excessive current in any part of the system. Short circuits of accidental character must be provided against. If the safeguards are not ample, a more potent fire producer than a short-circuited section of an extended multiple arc system, is hard to find. Take out your fuse wires and replace them with copper wires, a practice, instances of which were not difficult to find in times past, and a short circuit may quickly heat a long line of wire in a building, so as to set fire to the insulation of the wire and surrounding woodwork. The fusible wire cut-out, if properly made and used, is an effective preventative of such risks, though magnetic cut-offs are preferred by some, though more expensive. The magnetic cut-offs, which are simply open-circuiting switches controlled by magnets in the branch or line so as to open it on excessive current, have the advantages of promptness, avoidance of the scattering about of fused metal, and can be reset without any renewal of material; so differing from the case of a fuse wire. Another risk in such systems is that of creeping of current from main to main over moist surfaces, or partial conductors, in amount insufficient to blow a fuse, but sufficient to convert enough energy into heat to set a fire. Good waterproof insulation of wires avoids this risk if the insulation remains intact. I consider the plan of running the two branch wires, excepting the larger ones of the system, near together or close together, as excellent in avoiding this risk, provided the wires are encased in insulation and covered in or run in a tube. In case of a leak from main to main, the more quickly the fuses blow, the better, and the proximity of the wires assists this speedy action, while between the wires there is not at any time enough combustible matter to set afire by the short circuit. Enclosure in a tube effectually shuts off possibility of flame reaching combustible matter before the fuse blows. This does not apply to the heavier mains, capable of carrying thousands of ampères, so well as it does to the smaller branches. I am glad to note here that the tube or conduit system appears to be well worked out for inside wiring by the Interior Electrical Conduit Company.

Another thing to be avoided in extended systems of multiple arc work is grounding or leakage to ground of current over resisting surfaces or material. The tube system is useful here as well, and the placing of two wires at difference of potential, near together, assists somewhat, but does not entirely remove liability of grounding. Testing for grounds in the system, taken in sections, is the proper procedure, although this does not provide against all suddenly formed leaks. It may be argued that in this case two grounds are necessary to cause a leak, one on each side of the system, and this is true, but in very extended systems of overhead work, more or less general leak exists which may provide sufficient current to feed, as it were, a local leak to ground from either main.

Let us now deal with what is called the alternating, or induction system of supply, in which the local, or house mains, are separate from the primary mains, and of much lower potential. For lighting purposes the system is very flexible, and enables distance to be overcome. The secondary circuit is, or should be, entirely out of connection with the primary mains of high potential, and the potential differences of the secondary circuit may be so low as to be incapable of giving a severe shock under the conditions of use, and to be almost incapable of setting afire, on account of the absence of arc-forming tendencies. This is, indeed, an important factor in alternating current work, and conduces to the perfect working of switches and cut-outs, and the prevention of diversion to ground. Good work is all that is needed in this case to abolish all risks, if we leave out the main high potential current. The local line is unaffected by leaks or grounds at other parts of the system, and is, therefore, in this respect, in a better condition than is found with the consumer's lines in any direct system of supply. On the other hand, all the cases in which persons have received a shock from an alternating current of 1,000 volts or upwards, without being killed, are fortunate accidents, for there cannot be the slightest doubt that such current can, and will, kill under conditions favourable to its passage through the body. There are many cases of severe shocks having been obtained from such currents without permanent injury. On the other hand, there is a sufficient number of fatalities on record to sustain the position taken. The risks with higher than 1,000 volts alternating current are, of course, greater. It must not be forgotten, in this connection, that the actual potential differences in an alternating current of 1,000 volts are higher than that figure, and may be, at every wave, upwards of twice as much. This confers on such currents an actual and measurable striking distance between the two mains. As with arc lighting lines, the main or primary wires, if overhead, require to be kept thoroughly insulated and free from leaks to ground. The covering for the wire should be capable of resisting moisture, and the wire used be strong enough to prevent any possible breakage. If the primary wires break and come down, they are still kept charged from the dynamo, which is not always the case with arc light lines. If, however, the insulation is strong and perfectly good, the risk to life is small in such case. There is one fact I wish to impress, however, and it is, that with a perfectly insulated set of alternating primary mains feeding transformers, there still remains the static capacity of the line or cables and transformers, and this may be of an amount sufficient, if a person is grounded and touching the primary line, uninsulated, to give a severe if not a fatal shock. This inductive shock or discharge is, of course, far more pronounced with ordinary underground conductors than with aerial lines, and increases with the size and number of transformers and the extent of the line. It also increases as the voltage of the primary line is increased. Hence, it is quite important that no leak or connection exist between the primary line and a secondary in such system, or otherwise there may be a transfer of potentials of the primary line to the secondary so as to involve risk of shock to the consumer, or risk of fire from leaks to ground indoors. It will not do to say that such connections do not often form, for they may form from defects in construction, from moisture, and particularly from lightning discharges. A person standing on a damp floor, leaning on a steam radiator, touching a gas pipe grounded, or in other ways, may, if he handles or touches the secondary line at any part of it, be in peril of severe, if not fatal, shock. What was without this condition a most harmless local line, becomes most dangerous.

The writer early recognised this danger, and felt that unless it was provided for, the induction system was not advisable for general use. As a consequence, the expedients of grounding the secondary, or of surrounding the secondary by a grounded sheath, or of cutting off absolutely by automatic means the local line when connected with the main line, or of automatic grounding of the secondary by insulating films or spaces which are punctured or overcome by the potential of the primary when connected with the secondary, were devised as safety devices. The grounding of the secondary is the most simple and effective if good grounds be made. It must, however, be done with certain precautions to insure the best results.

The second expedient of a grounded metallic sheath between the primary and secondary is persistently called "Kent's sheath" when alluded to by our English cousins, despite the fact that it is American in its origin. It is effective as a protector, as it carries to ground any discharge leaving the primary before it reaches the secondary. The sheath is easily made by placing a somewhat open wrapping around either the primary coil or the secondary coil of the transformer made of flat metallic ribbon or insulated wire, the ends of which are grounded when in use. The course taken by the wrapping is around the wire of the coils at right angles to its direction of winding. The automatic absolute cutting off of the connection between the transformer coils is also effective, and has undergone several modifications in other hands. The last protective device mentioned above leaves the secondary insulated from the ground until a contact or leak from the

primary takes place, when an automatic ground is made. One of the forms consists in the interposition between the ground and the secondary coil or line of a film cut-out, or thin paper film between two metal buttons pressed together, one button connected with the ground the other with the transformer secondary. This device is very effective in securing a safety ground connection of the secondary when the primary leaks to it. A well constructed transformer properly installed will not, except by accident, lose its insulation between primary and secondary, and such insulation should always be many times than otherwise requisite, so as to have a margin of safety; but the safety device is none the less a necessity in its use.

I consider that a properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also inclosed in a grounded metal case, in the cellar of a building, a secondary line of low potential, grounded, or provided with safety devices as mentioned, embodies as safe a system of incandescent electric light distribution as can be devised, both as to risk to life and danger of fire. It insures complete safety to all the consumers and to each one individually. It enables long distance work to be undertaken, and allows low voltage lamps to be used with their increased economy. The risks are confined to the electric station and the primary lines which should be handled by men who know their business. The non-commutation of the current at the generators is another advantage of course. The disturbing influences, which in the best organised plant may be introduced by lightning, are serious and sometimes destructive. It is not that the lines are struck by lightning in causing such troubles, but the mere *inductive* current or discharge from a flash of lightning is quite sufficient. It puts upon the line potentials of many thousands of volts and tends to break down insulation everywhere. Lightning arresters are therefore important safety devices in more senses than one. They save the machines in the station and the apparatus outside. In the alternating system they save from puncture the insulation between primary and secondary coils of transformers and between the turns of the primary coil itself. Every plant then, should, if subject to lightning induction, be provided with efficient lightning arresters or dischargers.

A discussion of this general subject, however brief and necessarily restricted in scope, would be very incomplete without allusion to the subject of contact with telephone or telegraph wires with electric light conductors. Under ground and in conduits such contacts could not easily occur, though leaks might readily take place between lighting conductors and other wires. In any case, there is a risk of such wires carrying current into buildings or to positions bringing about shocks to persons, thus involving risk of fire or danger to life, or both. As a consequence, a set of safety devices have been brought out under various names, whose purpose is to cut off dangerous currents when they reach or traverse lines, such as those of the telephone and telegraph. It is my opinion that in cities the provision of approved devices of this kind should be compulsory. Most of those which I have seen are not well enough designed or made to be perfectly relied upon, but are much better than nothing, and may possibly suffice. Such apparatus, however, should be made so as to be perfectly reliable and undergo a regular inspection. Mere fuses, even if made long, are not enough. There should be placed in every circuit liable to contact with lighting or such like conductors, and at a place in the circuit where it enters a building, a protective device which, to be complete, should shunt, or absolutely cut off the section of wire indoors, or ground the same in case of abnormal current on the wire or abnormal potential.

There is much more to be said on this subject, and I am conscious of only having touched upon certain important matters in this paper. If I have succeeded in pointing the way to better conditions, in any case, I shall be more than satisfied.

To sum up briefly, safety in outside work means care in placing, maintaining and insulating conductors, whether used overhead or below ground. This means the employment of only good linemen, and not men who are ready to incur risks through a reckless disregard of conditions of failure to comprehend their importance. Men who have done telephone or telegraph line work are not necessarily prepared to undertake electric light and such other work with the best success. Safety in inside work means, primarily, if admissible, separation of the inside circuit absolutely from the general supply mains, and in any case it means that good, careful workmanship is requisite, and that the employment of safety devices, amply sufficient to do the work required of them in case of accident, is imperative.

Safety from current entering buildings upon telephone, telegraph and other wires, means, first, a more systematic placing of such lines apart from electric mains, whether above ground or below, guard wires and insulated wire for such lines; stronger wire, especially for telephones, and the employment of safety devices in case of accidental leaks or crosses occurring with electric mains of either low or high potentials, and a periodical inspection by proper offi

Cable for New Caledonia.—We learn that some submarine cable for New Caledonia will be shortly taken from the Government factory at La Seyne (Toulon) and carried to Marseilles, where it will be shipped on board a mail steamer for transport to its destination.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page 275.*)

9. Magnetising Force Required to Compensate the Backward Induction.

The weakening of the field by the current flowing in armatures wound on the Hefner von Alteneck principle has been studied by Drs. J. and E. Hopkinson; but from the fact that the lead upon which the weakening depends is in Gramme-wound armatures much greater, and to a large extent indeterminate, it follows that, in designing, some approximate rule must be employed to fit the types of machines in which these are employed. We may estimate the effect of weakening in two ways: First, we may excite the magnets with a constant current, and measure the fall of E.M.F. due to the armature current; or, secondly, we may, by increasing the magnetising force, keep the E.M.F. up to the same value when a current flows as when the machine is working at no load, measuring the ampère turns required to effect this compensation. The latter is the proper course to adopt, since having predetermined the magnetising force required for the induction in the armature at full load, on the assumption that there are no disturbing reactions, we wish to know what addition is to be made to the force so determined. The weakening of the field is much greater in cylinder than in drum machines, owing to the greater lead required to obtain a sparkless collection; accordingly the magnetising force necessary to compensate the backward induction must be greater for cylinders than for drums. Its actual value depends, necessarily, on several things besides the ampère turns on the armature, such as the degree of saturation employed, the ratio of armature to field section, the shape of the pole pieces, and the magnitude of the stray field. The particulars relating to the degree of saturation, the sections, stray field, &c., of the Phœnix machines have already been given, and from actual practice we find that there has to be added to the magnetising force, in order to compensate the backward induction in these machines, ·33 of the ampère turns on the armature. By the ampère turns on the armature is meant, as already stated, the product of the number of external conductors and half the total current. This is for a single horseshoe machine. If there is a divided magnetic circuit constituted by two horseshoes, with their like poles butting, the number of ampère turns here given has to be wound on each horseshoe.

I have met with some very curious rules for determining the compensating turns. These generally take the form of adding to the magnetising force determined for the required induction at full load such additional ampère turns as will increase the induction about 5 per cent. It is assumed that at full load the E.M.F. will be as desired, the 5 per cent. extra being for compensation. This method is, of course, incorrect, for the magnetising force added should be for a given machine some function of the armature windings. I believe that for most Gramme-wound machines the value of the compensation coefficient here given will hold good. The compensation coefficient for drum machines I have not yet been able to determine.

10. Total Magnetising Force.

To the magnetising force required for a simple magnetic circuit as given in 1, we have to add the force required to compensate the backward induction, as given above. The equation for the magnetising force now becomes for cylinder machines—

$$A_1 = L f\left(\frac{N}{a}\right) + L_1 \cdot 8\,\frac{v_1 N}{a_1} + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_2 N}{a_3}\right) + \ldots + \cdot 33\, A_2,$$

where A_2 is the number of ampère turns on the armature.

If the machine is to be shunt wound, and N is the induction corresponding to the E.M.F. at full load, A_1 gives the ampère turns on the shunt. If it is to be compound-wound, and N is the induction at full load, A_1 is the number of ampère turns on the series and shunt windings added. The ampère turns for the shunt alone are obtained by substituting for the induction at full load the induction on open circuit, the armature coefficient being of course here omitted. As a matter of fact, the value of v_2 increases between 0 load and full load, but for reasons already given this may in the calculation be neglected.

If the series coils are connected in series, to get the number of compensating turns on each horseshoe we have only to multiply the external conductors on the armature by ·165. It may be mentioned in passing that in the Phœnix dynamos the total series convolutions for ordinary compound machines are uniformly ·31 of the convolutions on the armature; this, multiplied by the current, being the magnetising force necessary to overcome the resistance of the armature and the series coils, and to compensate the backward induction. It will thus be seen that rather more convolutions are required for the latter purpose than for the former, and I think that in most dynamos of medium size the relation is very similar. The only extraordinary relation I know of is in the Victoria machine, where the compensating turns, instead of being a little greater than the turns required to overcome the resistance of the armature and series coil, are three times as great.

11. WORKING TEMPERATURE.

The ultimate rise in temperature of coils wound with double-cotton-covered wire, varnished on the exterior, is, approximately in degrees centigrade,

$$C^\circ = \frac{w\ 355}{s},$$

where w is the rate at which energy is dissipated in watts, and s the cooling surface in square centimetres. If for the latter, we substitute square inches, s_1, the equation is

$$C^\circ = \frac{w\ 55}{s_1}.$$

The coefficients have been obtained from practice, but they are liable to some uncertainty. In the cases from which they have been derived the coils were wound on formers of sheet iron, which fitted close to the magnets. These formers were fitted with brass end flanges, and in the spaces between the flanges and the wire, also between the body and the wire, was a thick layer of insulating material. The surface of the end flanges is not included as making up s or s_1, nor is the inside surface of the former next the magnet. Though insulated so well thermally, there is certainly a flow of heat towards the interior of the magnets and towards the end flanges, so that, as a matter of fact, the virtual cooling surface is greater than given above. Its value it is, however, difficult to determine, while the above equation is approximately true for machines of medium size, and may be used for all cases in which the coils do not exceed 2½ or 3 inches in thickness.

For armatures—which in rotating induce a current of air—the equation is different, and the coefficient given above may have a much lower value, according to the velocity and ventilation. For armatures the surface velocity of which is 50 feet per second (3,000 feet per minute), and the exterior diameter of the core 1½ times the interior, the length being about equal to the diameter, the rise is, approximately,

$$C^\circ = \frac{w\ 225}{s},$$

or

$$C^\circ = \frac{w\ 35}{s_1},$$

accordingly as the surface is taken in square centimetres or square inches. Here the whole of the cooling surface inside, outside, and at the ends is counted, w being the total watts dissipated in both electrical waste and hysteresis. The latter must, under no circumstances, be neglected, as it may reach 20 per cent. or more of the total. In giving the above equation, it should be stated that the armatures of the machines which furnished the results are closed at the commutator end, except at the periphery, where a draught of air through the centre from the pulley end is expelled. For slow-speed machines the coefficient is necessarily higher, and a larger surface must be allowed, or special means adopted, in the shape of vanes or blades, to force a draught through the armature. Experience can be the only guide here.

Considerable difference of opinion exists with reference to the temperature rise which should be permitted in dynamos. The rise of about 11° C. allowed by the Admiralty is admitted by all engineers to be absurdly low; while, on the other hand, the machines sent out by some manufacturers get at their normal output dangerously near the temperature at which the insulating material would become useless. We have to steer between these two extremes, working far under the critical temperature, but, at the same time, not making machines too costly on account of the excessive surface allowed. It will be observed that from the manufacturer's point of view the settlement of this point is of great importance, since a competitor, by allowing a greater temperature rise, may put in a machine of less weight, and therefore less costly, though not necessarily less efficient.

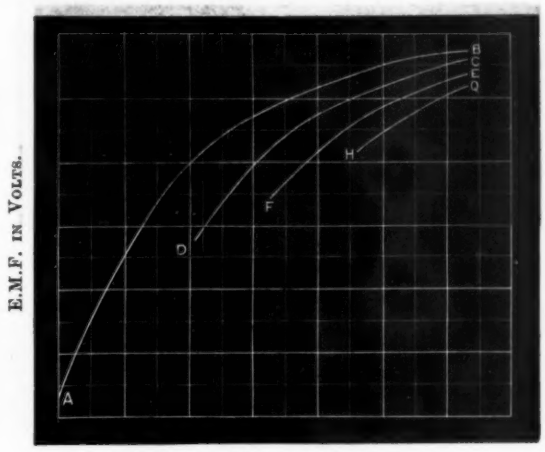
In any case, the ultimate temperature of the machine ought not to rise above a certain value, whatever the temperature of the room in which it works. In my opinion, an ultimate temperature of from 70° to 75° C. may be permitted with perfect safety, but this should not be exceeded. Independently of the ultimate temperature, the rise in working should not be too great, and accordingly we have in the Phœnix dynamo fixed this limit at from 30° to 35° C. Machines working in atmospheres up to 35° C. have a cooling surface, therefore, which will give in continuous working a rise of 35° C.; when the temperature is higher the cooling surface is increased, so that the maximum temperature does not exceed 70° C., the limit given. It will be seen from the formula that for a rise of 35° C. in the magnets, the cooling surface is 10 square centimetres (1·56 square inches) per watt.

For armatures having the proportion stated, the surface requires to be about 7·3 square centimetres (1·13 square inches) per watt; but here it is less easy to formulate rules. Both interior and exterior surfaces are ventilated by the motion, the former generally being of a broken character, which aids the cooling. The temperature of these surfaces does not measure the temperature of the bottom layers of wire or of the armature core itself, and when I speak of a temperature of 70° C., I mean, of course, that of the hottest part. The difference of temperature between the interior of the core and the outside surfaces, in a machine of given carcase dimensions, depends on the gauge of wire with which the armature is wound. Obviously, the difference of temperature required to produce a given flow of heat depends upon the thermal resistance encountered, and, therefore, on the number of layers of badly conducting substance, in the shape of cotton covering, through which the flow takes place. For this reason, an armature wound with one layer of coarse wire requires a less cooling surface per watt to keep down the internal temperature than an armature wound with fine wire, even if the mass of copper is similar. In practice, allowance for this is made by working the small-guage wires to a less current-density. On account of the flow of heat being obstructed by badly conducting substance, armatures with cores constructed of wire always get hotter inside than those with plate cores.

Of course it will be understood that the coefficient given for the rise of temperature will be greater for those armatures in which the central opening in the core is less than two-thirds of its external diameter. Where, for instance, it is half the external diameter, the inside radiating surface is diminished to three-fourths of that specified, and the temperature rise will be proportionally higher, unless a stronger draught of air is sent through the centre of the armature.

12. LOAD DIAGRAMS.

A dynamo having been completed, its performance should be recorded in such a manner that we shall be able to tell at a glance what a machine of similar carcase dimensions will under any circumstance give. First, the machine is run on open circuit, and the relation between the ampère-turns on the magnets and the E.M.F. established. In fig. 20, the curve



AMPERE TURNS ON MAGNETS.

FIG. 20.

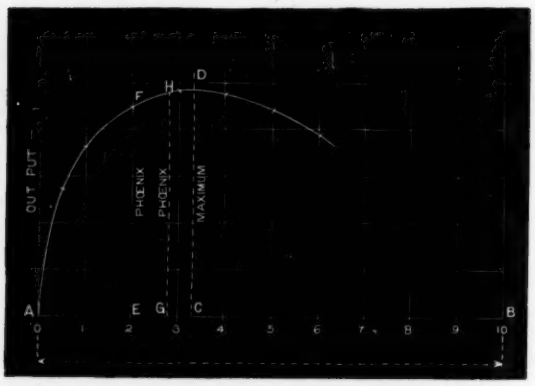
A, B shows this, abscissæ giving ampère-turns, and ordinates the E.M.F. While running at the same speed, take the greatest permissible current from the armature, and, keeping this constant, take observations of the magnetising force and E.M.F., the field being weakened down step by step until it is just possible by adjustment of the brushes to run without sparking. For each reading the brushes will have been adjusted to the sparkless position, and the curve expressing the relation between the magnetising force and E.M.F. when the maximum current flows may be plotted as at Q, H. The curve stops at H, because, with a further weakening of the field, a non-sparking position cannot be obtained. Repeat the experiment for a less current in the armature, then for a smaller still, until there is a series of curves—Q H, E F, C D—as shown, representing the relation between the magnetising force and the E.M.F. for several different values of the ampère-turns on the armature. It will be observed that as the ampère-turns on the armature get less, the curve can be carried lower, or, in other words, we can weaken the field to a greater extent before arriving at the sparking point.

This load diagram tells us everything we wish to know about the magnetic circuit of a machine having these particular dimensions, and about the interference of the armature on the field circuit. It tells us the ampère-turns required for any induction on open circuit, or, in other words, the magnetising force required for the shunt only if the machine is to be compounded; it tells us how many ampère-turns must be added to raise the E.M.F. by a required amount with any current flowing, or to compensate any armature load; it tells us how we can over-compound the machine; and, lastly, just how far we can weaken the field for any load without producing sparking. That we can by its aid calculate with accuracy the windings of any machine which requires the same carcase, will be sufficiently obvious without farther explanation.

13.—THE BEST RELATION BETWEEN THE IRON AND COPPER IN THE ARMATURE.

It is of some importance to know the best relation between the thickness of the iron core and the depth of the winding which will give in armatures the best results for given dimensions. Suppose we have a cylinder armature of certain radial depth over the winding; while keeping this depth the same, we may vary the

iron and copper of which it consists within wide limits. The question is, what relation of copper to iron will give the best results, premising that, however the relation is varied, the temperature shall remain the same. The cooling surface we will take to be unaltered, and this means neglecting hysteresis—for a reason given presently—that the heat generated in the winding shall be constant. Since the waste is constant, the point of maximum efficiency coincides, then, with that of maximum output. If the copper on the outside of the armature is considered as a shell of t thickness, we may, within the limits of our enquiry, take the current that may be carried to generate the same heat $= \sqrt{t}$. The E.M.F. produced will be proportional to the radial depth of the armature core, r, and assuming in each case the same degree of saturation, the greatest output for a given radial depth of armature is obtained when $r\sqrt{t}$ is a maximum. This occurs when the exterior layer of copper is about one-fourth the depth of the armature core, the output for different proportions between iron and copper being shown by the curve, fig. 21. In the diagram the base



HALF THE RADIAL DEPTH OF CORE.

FIG. 21.

line, A, B, represents half the radial depth of the armature over the winding, distances measured from left to right giving the thickness of the exterior shell of copper. The ordinates represent the output. A dotted line, C, D, is erected at the point of maximum. It may be assumed, without any great error, that the weight per unit length of circumference is constant, however the proportions vary, so that the curve may be taken to represent maximum output for a given weight as well as for given dimensions. With a square or bar winding this is about correct.

It will be observed that the relation of copper to iron can be varied considerably without making much difference to the output. An armature, for instance, in which the core is six times the thickness of the copper, gives the same efficiency as one in which the relation is 2·75, and the output is in each case only 3 per cent. below the maximum. The relation for greatest efficiency is quite independent of the degree of saturation to which the core is carried, or the temperature at which the machine is worked.

The effect of hysteresis is to reduce the height of the ordinates, and to displace the point of maximum efficiency to the right. The current which can be taken from the armature is a little greater than $\sqrt{t}$, on account of the heat from hysteresis diminishing as the core is reduced in thickness. But imagining that in all cases the core is saturated to the same degree, the difference in the amount of heat generated from this source is, within the limits of practice, so small a percentage of the whole that its effect on the shape of the curve may be quite neglected.

Machines are not always designed so that the proportions give maximum output, since other considerations arise besides that of the best result from the armature considered by itself. The question of magnetising the core has to receive attention, and the question is resolved into, What is the best proportion for the machine, considered as a whole? The answer to this depends entirely upon the design. In the Phœnix dynamos we work between the limits given by the two vertical dotted lines, E, F and G, H, in fig. 21, finding that there we obtain the best results. If we worked to the right we should get a greater output, we should have a greater air gap, a diminished flux through the armature core, but, on account of the increased stray field, about the same flux in the magnets. The magnetising force and the compensating turns on the magnets would be increased somewhat, while the cross induction would remain about the same. As regards this last point, it is worthy of note that the tendency to sparking, with the usual clearance spaces, remains about the same for considerable variation in the proportion of copper to iron. Increasing the copper does not increase the length of the air gap in the same ratio, but in a ratio rather greater than $\sqrt{t}$, or than the current which can be taken from the armature. At the same time the radial depth of the core is diminished, the final result being that $\frac{A_2\ w}{r}$ is about constant within the limits of practice.

For drum armatures the relation for maximum output can be similarly determined, and similar conditions fix the limit of departure from the maximum. One point with reference to these considerations should be noticed, and that is, that neither for cylinders nor drums does the point of maximum efficiency or output coincide with the point at which $\frac{\text{watts}}{\text{weight of copper}}$ or $\frac{\text{volts}}{\text{yards of copper}}$ is a maximum, and that these ratios, as applied to compare the performance of dynamos, are accordingly misleading. Given a limiting temperature, the only factors upon which the commercial value of machines should be based are cost and commercial efficiency. Whether the magnets shall be made of wrought or cast iron, whether there shall be a large amount of copper or a small amount, are questions for the manufacturer to decide. In some cases it may pay him to increase the copper and use cast iron, in other cases diminish the copper and use wrought iron. But the finished product is to be judged by its cost to purchase and its cost to run.

14. MOTOR DESIGNING.

These considerations naturally bring us to the subject of motor designing, about which there has been expressed from time to time a good deal of difference in opinion. From the preceding section it will be perceived how far we can go in the direction of getting an increased output from a given weight of armature; and it will have been understood from Section 4 that with somewhat lighter field magnets and a reduced saturation in the armature, a larger yield can be obtained for the total weight, though smaller for the weight of the armature itself. As a general rule, the question of weight does not enter into dynamo designing, except in so far as cost is affected, and a lighter machine means a somewhat increased cost for the output. But in motors it is sometimes necessary to keep the weight as low as possible, and the point to be emphasised here is that in designing light-weight motors we proceed upon lines precisely similar to those adopted in designing light-weight dynamos.

It has been asserted that in motors the armatures ought to be larger compared with the field magnet than in dynamos; and by "larger" must be meant either that the armature cross section is greater, or that the ampère-turns on it are more numerous. As regards the former, it has been shown in Section 4 to what extent the relation between the cross sections of the armature and fields influences the dynamo, and the same reasoning applies to motors; as regards the latter, curiously enough, the examples which I have given in Tables II. and III. show no overloading, but about the same number of ampère-turns is carried as by dynamo armatures—a fact which does not favour the "large armature" school.

My own experiments with series machines, in which the brushes had equal lead and trail when running as dynamo and motor, seem to show that the difference in the E.M.F. generated under these two circumstances is negligible. In Table IV. are given the results.

TABLE IV.—SERIES MACHINES RUN AS GENERATOR AND MOTOR.

Machine.	Revolutions per minute.	V_1.	V_2.	C.	$V_1 + CR$.	$V_2 - CR$.	Diff.
			GRAMME ARMATURE.				
Phœnix	820	58	136	12·0	98·00	96·00	−2·00
	1,700	134	168	5·0	150·60	151·30	0·70
	1,800	136	168	4·5	151·00	153·00	2·00
			PACINOTTI ARMATURE.				
Phœnix	820	47	80	4·5	63·00	64·00	1·00
	940	58	96	5·0	75·30	78·70	3·40
	1,295	87	130	6·0	107·70	109·30	1·60
	1,430	104	152	6·75	127·30	128·63	1·26
	1,520	106	158	6·75	131·13	132·87	1·74
			BURGIN ARMATURE.				
Bürgin	500	16	116	14·0	64·67	67·40	2·73
	640	36	130	12·5	79·46	86·54	7·08
	720	60	98	4·25	74·11	83·89	9·78
	780	59	138	10·0	93·77	103·23	9·46
	830	66	142	9·0	97·30	110·70	13·40
	840	72	118	4·5	87·00	103·00	16·00
	860	70	144	8·75	100·40	113·60	13·20
	1,100	104	152	4·75	119·77	136·23	16·46
	1,180	114	164	5·0	130·60	147·40	17·20

V_1 = Difference of potentials at terminals as generator.
V_2 = Difference of potentials at terminals as motor.
C = Current, in ampères.
R = Resistance of machine in ohms.

The cores of the Gramme and Pacinotti armatures were constructed of iron washers separated from each other by paper while the Bürgin armature consisted of a series of hexagonal rings made of iron wire, each forced on to a six armed gun metal spider. The small differences in the last

column may be readily accounted for in the case of the Gramme and Pacinotti armatures by errors of observations, as several things had to be measured simultaneously; but no allowance for errors can account for the difference in the case of the Bürgin machine, I talked over these experiments at the time with Mr. Kapp, who suggested that the difference might be due to parasitic currents arising from imperfect lamination, the forcing of the hexagonal rings on the spiders bringing the wires of the core into actual contact at the corners. When the currents are flowing in the same direction through the machine, the armature rotates with reference to the field in the opposite direction of course as generator and motor. Now, apart from the question of parasitic currents, with an irregularly formed armature like the Bürgin—and the Brush with its eight or twelve projections would come in the same category—one is not surprised at a difference in the E.M.F., the wonder would be if the direction of rotation did not alter the field. But with a Pacinotti ring in which the slots are many and close together, the influence on the field is slight and with smooth Gramme armatures the field is not affected by the direction of rotation at all, so we get the same E.M.F. produced as generator and motor.

It must be remembered that the effect of the armature current on the field in cylinder machines is by no means small, as will have been observed by the number of compensating turns required to neutralise it. A machine having 13,500 ampère turns on its armature would have about 20,000 on its field magnets, out of which about 4,500 are compensating turns. I mention this to show that the results in Table IV. were not obtained from machines in which the armature effect was negligible, or anything approaching it. The saturation of the core was about 17,000 C.G.S. units.

If a machine is run at the same speed as dynamo and motor, provided the currents in the fields and armature are similar, it will always have a higher efficiency as a motor. If E is the E.M.F. generated by the machine, C the current (imagine it series wound), and R the resistance, the electrical efficiencies as dynamo and motor are in the ratio of $\frac{CE - C^2R}{CE}$ to $\frac{CE}{CE + C^2R}$, the latter being the greater quantity. If we designate all the other losses save that due to the resistance by p, then for the commercial efficiency we have $\frac{CE - C^2R}{CE + p}$, and $\frac{CE - p}{CE + C^2R}$. If p had the same value as C^2R, the efficiency of dynamo and motor would be similar; but since p has always a lower value than C^2R, the motor has still the advantage.

15. Constant Potential Motors.

Now as regards another thing which we have been told sometimes—that the armature and magnet fields are added in a motor—so far is this from being the case, that, under the usual and proper conditions of a trail on the brushes, the weakening of the field due to the current in the armature may play a most important part in the governing of motors at constant speed. In an article contributed to the *Electrician* in 1886,* I hinted at this, saying, "By reason of the current in the armature reacting to weaken the field, does not a shunt motor contain within itself the germ of self-regulation, which, by suitable proportion, may be made effective without a series coil at all?" Since that date motors have been constructed in which the truth so foreshadowed has been realised.

As already stated, the E.M.F. of a separately excited dynamo is represented by an inclined line, C D, fig. 15, the inclination showing the weakening of the field produced by the current in the armature. Run as a motor, with a trail equal to its lead as a dynamo, the E.M.F. generated—called in this case the back E.M.F.—will be the same, being greater, therefore, as the current is smaller, and smaller as the current is larger. A shunt motor connected to mains at a constant difference of potentials has its magnets excited by a constant current, and the back E.M.F. varies in this way. Its value, calling E_1 the difference of potentials at the mains, is $E_1 - CR$, and it is, of course, proportional to the induction through the armature and the speed. Generally we require the latter to be constant, so we write,

$$n \propto \frac{E_1 - CR}{N_1},$$

where N_1 is the resultant induction through the armature due to both fields. As we have seen, N_1 is not a constant: there is a weakening of the field proportional to the current; and for N_1 we can substitute a value, $N - f(C)$, where N is the induction on open circuit, and $f(C)$, that function of the current which represents the weakening effect. Writing

$$n \propto \frac{E_1 - CR}{N - f(C)},$$

it is perfectly obvious that if CR bears the same relation to E_1 as $f(C)$ bears to N, the speed, n, will be constant, and quite independent of the load. Referring to fig. 15, the height, O C, may be taken as representing the induction when the motor is running with no load; the sloping line, C D, giving the induction for various currents in the armature. The horizontal line, C E will represent the induction due to the field magnets alone, and the difference of potentials at the mains. If the speed be constant, the length of ordinates between C D and C E represents $f(C)$, and also CR. We see clearly that if the induction is diminished without a proportional reduction of the back E.M.F., the speed will increase; while, on the other hand, if the back E.M.F. goes down without a corresponding decrease in the induction, the speed will be reduced. If it is found that the speed increases as the motor is loaded—and I have seen this—the field must be strengthened, and the turns on the armature reduced, or the armature resistance increased, If the speed gets less, an opposite course must be taken. A shunt motor, then, will run at a constant speed on a constant-potential circuit without compound winding or any other device, if the armature field and magnet field are properly proportioned. A position can generally be found for the brushes where the sparking between the load limits is inappreciable, and the motor may be then trusted with perfect confidence to run at a constant speed.

It must not be thought that because a motor transmits power, it is necessary to manipulate electro-mechanical equivalents until we get torque in pound-feet or foot-pounds per revolution, or some other mechanical quantities. This is only a waste of time. In designing a motor, we know the horse-power or watts to be given off on the brake at a certain speed, and if we make the machine run at the proper number of revolutions, and in accordance with the conditions of electrical supply, the torque will come out all right without our troubling about it. Suppose we require W watts to be given out on the brake by a motor working on a constant potential circuit. The power which must be converted in the armature is greater by a certain amount, p, absorbed in friction of journals and brushes, magnetic friction, and parasitic currents. This amount can be foretold to a certain extent, but may be derived from experiments made with machines of the same kind. The power converted being, then, $W + p$ watts; the back E.M.F. being settled as determined by the waste allowable in the armature, the current $= \frac{W + p}{E}$ is obtained; the procedure in design now being exactly as for a dynamo to give a current of $\frac{W + p}{E}$ ampères by E volts at the same speed. If these conditions are fulfilled, the torque may be left to itself.

16. Constant-Current Dynamos.

There seems to be an impression that dynamos for high differences of potentials cannot be worked successfully with Gramme commutators; the reason for this opinion being, I suppose, the breakdown of some imperfectly constructed machines. That there is no difficulty with the insulation between the conductors and armature core is obvious from the fact that high potential alternating current machines are working successfully with armature sections similarly disposed; the fault appears, therefore, to have been solely with the commutators. I need only reiterate the remark I made here a short time ago—that there is no difficulty whatever in constructing Gramme machines up to 1,000, 1,500, or even 2,000 volts, provided the designer knows what he is about. Many such machines are to be seen in daily work. Mr. Bogue, of New York, gives me particulars of a Wood dynamo manufactured by his company which gives 9·6 ampères, and a difference of potential of 2,640 volts at its terminals; Mr. Henrion, of Nancy, constructs Schuckert machines of 1,000 volts; Messrs. Immisch & Co. have constructed motors as well as dynamos of 1,000 volts; while Messrs. Paterson and Cooper have a large number of machines running at voltages varying from 800 to 1,500. The latter run without sparking at the brushes, and with perfectly smooth commutators.

Several attempts have been made to compound machines for constant current, all of them uniformly unsuccessful. It is beginning to be realised that—Deprez notwithstanding—it cannot be accomplished, and during the next six years the equations for constant current compound winding may finally disappear from our text-books. But it may take longer.

The method of regulation about which I have to make a few remarks is that of rotating the brushes on the commutator, which has proved very successful in some of the machines to which it has been applied. You need scarcely be reminded that if a series-wound machine is directly belted to a separate engine, the combination is almost self-regulating, such small correction as is required being easily effected by a solenoid electrical governor. In such cases the speeds of both engine and dynamo vary as the E.M.F., but generally this arrangement is not permissible, in consequence of several machines being driven from the same countershaft; accordingly some device for regulating at constant speed has to be adopted.

In machines in which the current is variable we endeavour, as I have said, to make the self-induction as small as possible, and we work with the brushes somewhere between the polar tips where the field is almost neutral, or only of strength sufficient to overcome the slight effect of self-induction, and bring the current up to its normal value before the section leaves the brush. In constant current machines we work always in the active field under the pole pieces, and to prevent the flow of an enormous current in the section short-circuited by the brush, considerable self-induction has to be given. Consider an armature in the field, fig. 16. Opposite the parts marked N and S the induction through a section is *nil*; at A and B it is 16,000, 17,000, or 18,000 C.G.S., as the case may be—that is, in the machines we have been speaking of hitherto. If we had here a uniform distribution of field over

* Review: "Electric Transmission of Energy," by Gisbert Kapp, the *Electrician*, vol. xvii., page 135, 1886.

the poles, an attempt at constant current regulation by movement of the brushes would only result in sparking, since in every position the back E.M.F. of self-induction is different. If the induced E.M.F. were in one position balanced by the E.M.F. of self-induction, in other positions it would be over balanced or under balanced. Another point is, that if regulation is attempted by working with the brushes partly between the polar tips and partly under the poles, the weakening effect of the armature current on the fields is subject to great variation; accordingly the poles should be extended until the brushes are under them in every position. The essentials for successful regulation will now be apparent. First, the self-induction should balance the field in every position of the brushes; secondly, the poles should be extended so that the brushes in every position of working are under them. An examination of the curve, fig. 1, will show that up to an induction of 12,000 or so the coefficient of self-induction is, roughly, constant; so that an armature core saturated to this degree would have the same E.M.F. of self-induction for a constant current, whatever the position of the brushes. In the Wood dynamo already referred to the induction in the armature is 13,000 per square centimetre, and in the Sperry dynamo, which hails from Chicago, it is about 14,000. Mr. Sperry's remarks I give in full in the appendix, also those of Mr. Bogue concerning the Wood machine. In both these machines the masses of iron in the magnets and pole pieces are disposed so that the field is fairly uniform over the poles; but this is by no means necessary, provided the E.M.F. of self-induction balances the field in every position. Making the field distribution uniform, and the self-induction uniform, affords the easiest method, however, of attaining the end in view. It remains only to say that the field at the short-circuited section is greatly reduced in strength by the current in the armature, and that the best number of turns per section must be determined by experiment. It will be evident that the single magnet type of machine, as illustrated in fig. 7, is the least suitable for constant current; and while in America they choose the best form of magnet for the purpose right away, in this country the attempts at regulation have been made very often by selecting the worst form and chopping away at the poles until it comes about right.

It is unnecessary to describe the various forms of apparatus for shifting the brushes. Briefly, they consist of a mechanical device, electrically controlled, whereby the brushes are moved forwards or backwards on the commutator as the current rises or falls slightly. Upon the rapidity with which this regulator responds to variations in the current depends the successful working of the machine. If the current is allowed to rise or fall outside a small percentage, the adjustment of the fields is thrown out of balance and sparking results. The importance of having a regulator which is sensitive, and acts with promptitude, will therefore be apparent.

17. Relation of Size to Output.

Great differences of opinion exist about the relation of size to output in dynamos. Professor Thompson in his "Dynamo-Electric Machinery," quotes several writers who give the output at figures varying from the square to the fourth power of the linear dimensions, and the subject has been discussed to some extent in this room. Mr. Kapp has worked out the relation, and, assuming that in larger machines the space taken up by the insulation is proportionally less, more copper being accordingly got on the armature, he makes the output for a machine whose linear dimensions are increased n times from n^3 to $n^{3\frac{1}{2}}$, the speed being inversely as the linear dimensions. Prof. Ayrton thinks it ought to be higher than $n^{3\frac{1}{2}}$, while Dr. Hopkinson finds that, everything considered, it comes out about n^3. With the single exception of Dr. Hopkinson, I am not aware that anyone has mentioned *the* consideration which, above all, determines this relation—that is, the interference of the magnet and armature fields.

If the armature of a machine is lengthened, the electrical work which can be performed by it is increased in proportion. The magnetising force and the ampère turns on the armature remain the same, and the forward and cross induction bear to each other the same ratio. Here the electrical work for the same number of revolutions per minute is proportional to the weight of the magnetic system, and rather more than proportional to the total weight. The surface velocity of the armature is, of course, unchanged. Let all the linear dimensions of the magnetic system be increased n times. The length of each component of the magnetic circuit being n times longer, the magnetising force must be n times greater for the same degree of saturation, the total forward induction having n^2 times its former value. The copper on the armature being n times thicker, the ampère turns which may be carried to raise it to the same temperature will be n^3, and the output, therefore, at the same number of revolutions per minute, $n^{3\frac{1}{2}}$, the E.M.F. being n^2. If the speed is inversely as the linear dimensions, the output is, obviously, $n^{2\frac{1}{2}}$. Now, in increasing all the linear dimensions—the air gap in proportion—we have increased the tendency to sparking. The lengths of the cross circuits are n times longer; consequently, for n times the ampère turns on this armature, the ratio of the cross induction to the forward induction would be as formerly. But we have put on it n^3 ampère turns, and the air gap must be therefore increased in the same proportion, in order that the tendency to sparking may be neutralised. Under these circumstances the magnetising force will be greater than n; but, taking into account the increased air gap, and the increased compensating ampère turns on the magnets, the weight of copper on these will not be greater than n^3; and this amount we can afford to have on a machine in which the other weights are increased in similar ratio. It appears, then, that, with due regard to the balance of the magnet and armature fields, the output is not quite proportional to the weight, if the surface velocity of the armature remains the same, but that for similar machines it increases as the $2\frac{1}{2}$ power of the linear dimensions. Of course this depends to a great extent upon the original machine. If the armature of this is under-loaded, it may be quite possible in the larger machine to take advantage of the condition that less space is taken by the insulation, and so load it to a greater number of ampère turns than n^3; but if the balance of fields is to be the same in each, n^3 represents the permissible ratio of ampère turns. It will be found, I think, that where the output increases directly as the weight, the surface velocity of the armature is in the larger machines greater.

With these remarks I bring this somewhat lengthy contribution to a conclusion.

Appendix.

The following are copies of the letters referred to in the text respecting the "Wood" and "Sperry" dynamos:—

"New York, *December 2nd*, 1889.

"W. B. Esson, Esq., London, England.

"Dear Sir,—In reply to your letter of October 21st, requesting data of machines made by this company, I send you the following:—Difference of potentials at terminals of machine, 2,640 volts; current, 9·6 ampères; revolutions per minute, 875; sections in commutator, 120; convolutions per section of armature, 72; cross section of iron in armature ring, 14 square inches. Pole pieces are bored concentrically with the armature; sparking at the brushes is eliminated by the use of an extra brush connected to collecting brush, with a separation on commutator of from five to ten sections, depending on the load, or, in other words, a counter E.M.F. to reduce spark. I must apologise to you for the delay in answering your letter, and hope that I may be in time for you to make use of data as intended.

"I am, Yours truly,

"Charles J. Bogue,

"*The New American Electrical Arc Light Company.*"

"Chicago, *June 11th*, 1889.

"Mr. W. B. Esson, West Hackney, N.E., London.

"Dear Sir,—Yours of October 21st at hand. Am pleased to notice contents, and in reply would say that the matter of regulation by shifting the brushes I have gone into as exhaustively, perhaps, as anyone in this country. I have had unlimited capital at my disposal, and have made an exhaustive series of experiments, and can say from knowledge that it depends for its success almost solely upon what we know as the balance between the armature and field. This might more properly be termed the preponderance of the induction of the field over that of the armature. . . . . In the machines we build, the brushes can stand in any position from 0 E.M.F. to full E.M.F. without a particle of sparking upon the commutator, the commutator wearing smooth, and glazing over with any position of brushes.

"The machine at the Paris Exposition is a 14-inch machine; that is, the exterior dimension of the armature is 14 inches. The actual exterior dimension of the core when ready for winding is $13\frac{1}{4}$ inches.

"The normal speed of machines of this size is about 1,000 revolutions. The E.M.F. of the armature at the brushes, before going through the fields, is about 620 volts, with ten ampères in the fields.

"The internal dimension of the core is $10\frac{5}{8}$ inches, and the length of the core is $6\frac{1}{4}$ inches. The insulation in mass of core is $20\frac{1}{2}$ per cent. There are 72 sections in the commutator. There are four layers, with ten convolutions in each layer, of wire upon the armature. From these dimensions you can get the actual area of iron.

"The field is bored perfectly concentric with the armature, and a good liberal clearance is allowed, usually about $\frac{5}{32}$ of an inch exterior to the bands of the armature—perhaps $\frac{1}{32}$ less in the case of small machines.

"Yours very truly,

"Elmer A. Sperry."

NEW PATENTS—1890.

2945. "Improvements in and relating to, and in the manufacture of electric secondary cells." A. M. F. Laurent-Cely and I. A. Timmis. Dated February 24.

2957. "Improvements in electric meters." J. J. A. Aubert. Dated February 24. (*Complete.*)

2963. "Improvements in the arrangements for, and mode of working electric and other railways, in such a way that all may be introduced collectively, or singly as auxiliaries to existing railways." R. C. Sayer. Dated February 25. (*Complete.*)

2986. "Improvements in electric lamp sockets and devices attached thereto for regulating the light." W. F. Wollin and E. H. Werline. Dated February 25. (*Complete.*)

2996. "Improvements in electric meters." R. J. F. MOSTYN. Dated February 25.

3008. "Improved storage or secondary batteries." W. B. HOLLINGSHEAD. Dated February 25. (*Complete.*)

3024. "Improvements in electric motors." H. H. LAKE. (Communicated by E. B. Parkhurst, United States.) Dated February 25. (*Complete.*)

3028. "Improvements in dynamo-electric and electro-dynamic machines." A. C. REIGNIER. Dated February 25.

3058. "An improved electric and tubular pneumatic action in organs, and in means of working the combination pistons of the same." J. J. BINNS. Dated February 26. (*Complete.*)

3071. "An electric meter." W. J. S. BARBER-STARKEY. Dated February 26.

3082. "An improvement in filaments for incandescent electric lamps." R. LANGHANS. Dated February 26.

3094. "Improvements in portable electric lamps, more especially intended for miners' use." THE MINING AND GENERAL ELECTRIC LAMP COMPANY, LIMITED, D. G. FITZ-GERALD, and A. H. HOUGH. Dated February 26.

3096. "Improvements in electric meters." S. Z. DE FERRANTI. Dated February 56.

3097. "Improvements in electric meters." S. Z. DE FERRANTI. Dated February 26.

3152. "Improvements in the manufacture of electrical conductors." W. A. THOMS. Dated February 27.

3153. "An improved mode of manufacturing electrical conductors." W. A. THOMS. Dated February 27.

3169. "Improvements in electro-heating apparatus." C. E. CARPENTER. Dated February 27. [Date applied for under Patents Act, 1883, section 103, 6th August, 1889, being date of application in the United States.] (*Complete.*)

3193. "Improvements in and connected with transformers, electrical measuring instruments and insulation." J. SWINBURNE. Dated February 28.

3196. "Electrical and steam application for actuating separate and independent alarms in connection with valves." S. WALKER and G. M. RADCLIFFE. Dated February 28.

3231. "Automatically regulating and keeping constant the electromotive force or pressure of any electric circuit." J. SHIPP. Dated February 28.

3271. "Improvements in dynamo-electric machines." C. N. RUSSELL and R. A. SCOTT. Dated March 1.

3272. "Improvements in switches for controlling electric circuits, especially electric light circuits." G. E. FLETCHER. Dated March 1.

3276. "Improvements in telephonic apparatus." A. WHALLEY. Dated March 1.

3304. "Improvements in apparatus for enabling a supply of gas or other fluid, or a current of electricity, to be obtained for a limited time on prepayment therefor." M. C. GREENHILL. Dated March 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

997. "Improvements in secondary or storage batteries." T. CUTTRISS. Dated January 19. 6d. Claims:—1. An outer cell of lead containing a lining of active material rendered self-supporting, substantially as described. 2. An outer cell of ebonite, glass, or other suitable material, containing a lining of active material rendered self-supporting, and containing strips of lead or platinum between the outer cell and the lining of active material, or embedded in the active material, substantially as described.

1460. "Improvements in secondary battery plates, elements, or supports." J. S. SELLON. Dated January 26. 6d. Consists in so casting the grid, or support, that its alternate ribs on opposite sides instead of being coincident as hitherto are alternately reversely situated respectively on each side, and that their position is so arranged that the active material, when applied, becomes interlaced, as it were, and securely held in position by such alternation. 2 claims.

13541. "Improvements in electric wire and pole connectors." C. R. BONNE. (Communicated from abroad by Mix and Genest, of Berlin.) Dated August 27. 6d. Claim:—The method of connecting electric wires and poles by means of an apparatus consisting essentially of a hollow main body, into which a cone or wedge can be forced in such a manner that any wires inserted between the cone and the internal walls of the main body become jammed, substantially in the manner as described and shown in the drawings.

13557. "Improvements in or connected with holders or sockets for incandescent electric lamps." J. Y. JOHNSON. (Communicated from abroad by J. W. Collier, of New York.) Dated August 27. 6d. The socket or holder is made of hard rubber or other non-conducting material, into which are moulded and inbedded all the contacts and fixed circuit connections, so that the screws and other appliances and fittings heretofore used for securing in place these parts are dispensed with. The holder has a socket proper for the reception of the neck of the lamp, and a chamber for the reception of the metallic cam or switch piece, by which the circuit through the holder is controlled, the said chamber and socket being formed on opposite sides of a permanent non-conducting diaphragm or partition formed in one piece with the body of the holder. The switch or cam chamber is closed by a cap, through which the current-conducting wires pass, the said cap being removable, and serving not only as a means by which the holder can be attached to a supporting bracket, and by which the switch chamber is sealed, but also as a means whereby the conducting wires, without other instrumentality, are clamped in place into secure connection with their respective connections in the holder. 4 claims.

13800. "Improved supports of secondary batteries." G. E. HEYL. Dated September 2. 6d. Relates to an electrode possessing as support for the active material a treillis-work or skeleton of lead or in active alloi. The fields may be surrounded, by narrow openings parallel to their edges, or the ribs between the separate fields are not massive as in other constructions but divided or split in the middle, so that intervals are formed permitting the expansion of each of the fields. 3 claims.

13841. "Combined telephonic and graphophonic apparatus applicable for transmitting, receiving, and recording sounds." M. WHELESS. Dated September 3. 8d. Consists in placing two graphophones in circuit so that the vibrations produced at one graphophone by the recording stylus moving over the cylinder shall be taken up by the reproducing stylus and be reproduced at the other graphophone making identical indentations there at the same time, to be transferred into sound waves. 6 claims.

14232. "Improvements in dynamo-electric machines." H. J. ALLISON. (Communicated from abroad by A. S. Fitch, of New York.) Dated September 10. 8d. Relates to dynamo-electric machines, which are specially adapted for developing a current of electricity for firing fuses in blasting operations and kindred uses; and consists primarily in the combination with the device which operates the rotary armature of a dynamo-electric machine, in which are two distinct and separate circuits, one including the armature, magnet coils and connections inside the machine, and the other comprising the working circuit, in which are the fuses, outside the machine, of a circuit controller common to both said circuits, and adapted to have motion concurrent with said armature-operating device, and to maintain the inside circuit closed and the outside circuit open or broken during the movement of said operating device in one direction to rotate said armature, and to establish electrical connection between said inside and outside circuits at the conclusion of said movement of said operating device. 12 claims.

14504. "An improved instrument for regulating electromotive force and current." W. H. DOUGLAS and T. H. PARKER. Dated September 14. 8d. Relates to the use of a differential device which is so arranged as to compensate for change of temperature. 3 claims.

14565. "Improvements in the method of and apparatus for recording telegraphic or other signs, more especially applicable to syphon recorder telegraphic instruments." G. DRAPER and W. H. ASH. Dated September 16. 6d. Claims:—1. In an instrument for recording telegraphic or other signs, the method of causing ink or other similar fluid to flow from the syphon on to the paper by mechanically vibrating the framework from which the syphon is suspended, substantially as and for the purpose described. 2. The combination with the arrangement for vibrating the framework from which the syphon is suspended, of an electric trembling bell movement together with means for adjusting the rate of vibration of the syphon, substantially as described.

14666. "Improvements in electric conduits for street railways." J. W. RENO. Dated September 17. 8d. The object of the invention is to provide an improved electric conduit for street railways and to use that form of rail known as the "girder" rail to form part of the conduit. An important principle of the construction is that only the upper part of the conduit is continuous, and in this way great strength to resist the heavy traffic of the streets is obtained, thus obviating the use of heavy iron yokes, set in concrete, common in other systems. 7 claims.

15045. "Improvements in electric switches and safety fuses for supply station distributing boards." C. M. DORMAN and R. A. SMITH. Dated September 24. 8d. The inventors arrange all the contact pieces which are connected with the various sources of supply or distributing circuits, or generally any part of the distributing switch fuse or coupling apparatus, which, when the switch is open has a high electric potential in such a position that they cannot easily be accidentally touched by the hand or other part of the person of the operator. This position is generally on the back of the slab or board to which the apparatus is fixed and not in front where the operator generally stands. 3 claims.

15377. "Improvements in electric machines or motors." C. C. PECK. Dated October 1. 8d. By the invention an increased torsional effort of the motor is obtained by having both the field and armature composed or made up of a number of independent magnets, the outer periphery of each armature magnet being made eccentric to the inner periphery of the field magnets, whereby a uniform movement of approach of the surface of one magnet toward the surface of the other is obtained to gain or effect a uniform or steady force tending to revolve the shaft and thereby obtain the maximum power. 5 claims.

15446. "Improvements in the method of and apparatus for 'forming' or charging plates for electrical accumulators." S. C. C. CURRIE. Dated October 1. 8d. Relates to a novel method of "forming" the plates by which they are prevented from expanding outward and particularly in the direction of their planes and in which the expanding force is expended within the plate itself, which expansion exerts a uniform and even pressure throughout its body, thereby increasing its density without correspondingly increasing its bulk. A further object of the invention is to provide a cheap, simple and efficient apparatus in which the parts thereof can readily be assembled and separated and so that the plates to be "formed" may be held during the process of "formation" rigidly and firmly against expansive action, whereby hard and compact plates or elements of uniform density are produced. 10 claims.

15721. "Improvements in electric motors." H. GROSWITH. Dated October 7. 8d. Relates to electric motors of the "Gramme" type, in which the power is furnished by a cylindrical armature revolving in a vertical plane between the poles of a fixed field, and it consists in the improved construction and combination of parts of the armature and commutators of an electric motor of that class as set forth. 7 claims.

15819. "Improvements in devices for connecting the plates of one electric battery with another battery or batteries, and with a switchboard or transmitting device." W. F. SMITH. Dated October 8. 8d. Consists of a connecting device having a divided male thimble provided with strips or ribbons, and having a cap and a female thimble fitted to the respective ends thereof. The said female thimble being secured to said male thimble, so as to leave a space between the two thimbles for the introduction of mercury or other suitable material, whereby a continuous path for the passage of the electric current or currents through the device to the battery or batteries is ensured. Further consists of a divided male thimble having a cup or female thimble and a plug with a flexible conductor leading to a switchboard or transmitting device. Further consists in depositing on the surfaces of the device a coating of conducting material such as nickel or other preferred material or substance, by electrolysis or otherwise, to prevent the mercury or other material contained in said device from deteriorating or destroying the same by amalgamation, whereby the electrical conductivity of the device is increased, and in the space between the female thimble and the strips or the male thimble is interposed a gasket or gaskets of rubber of other suitable material to prevent the gases evolved during the operation of the battery from corroding the connecting device. 11 claims.

CORRESPONDENCE.

Sectional Conductors for Electric Tramways.

Prof. Ayrton's letter on my system of applying electricity to tramways contains the claim for priority, which may confidently be expected from him whenever any electrical invention is made public.

The sneering allusions to my supposed American nationality, and to the extreme youth of my invention, as well as a slang expression which I do not understand, may be passed over with the silence they deserve. I shall therefore confine myself to dealing with Prof. Ayrton's specific claim to priority.

Prof. Ayrton bases these claims on his and Prof. Perry's patents, Nos. 783, 1881, and 2,395, 1883.

As I stated in my former letter, patent 783, 1881, refers to mechanical means of connecting sectional insulated rails of considerable length with a main insulated conductor, and for the single expressed purpose of reducing leakage of the current supplied to electrical trains.

That the sections of this insulated coil are of considerable length is apparent from the following quotation (patent No. 783, 1881, page 9, line 23, *et seq.*) :—"In all our arrangements, previously described, the distance between each contact box and the next varies from about 20 to 50 feet, so that there are several contact boxes in each section of our insulated rail, and several sections of an insulated rail in one section of the line blocked; but the following illustrates one of our methods for making each section of our insulated rail or conductor which is rubbed by a passing train a mile or more in length; in fact, as long as the particular system employed to insulate the rubbed conductor will allow." It is clear that the use of sections made so short as to provide for the protection of the public by keeping those sections which are charged under the car has not occurred to Profs. Ayrton and Perry; in fact, from beginning to end of these patents there is not one word to show that these Professors had any other ideas than of modifications of Prof. Fleeming Jenkins's system of electrical trains; not one word as to the special difficulties of applying electricity to urban tramways, or to means for overcoming these difficulties.

I must also traverse the statement which Prof. Ayrton makes in his letter in the following words:—"Then it is explained that the insulation of a conductor on the ground, as, for example, the ordinary rail, is sufficient in certain cases to enable it to be used as the sectional conductor."

Will he kindly point out where this explanation occurs? The sentence immediately preceding the above is a quotation from the *final* specification, the two lines he quotes in support of the above are from the *provisional* specification, and occur in the following sentence, which is markedly omitted in the final (783, 1881, page 2, line 28, *et seq*) : "We may modify our apparatus by dispensing with a third elastic rubbing rail, as before described, *insulating instead, by the best known means*, one of the carrying rails, dividing and insulating the said rail at the usual fish-plate or other joint into sections of suitable length, insulated from one another as perfectly as may be; contact between such sectionally-insulated rail and the main well-insulated conductor may be made by the wheel tyre or special roller pressing upon long rods parallel to the rail, with contact pieces at their ends." The italics are mine. There is not even in this any suggestion that they should be insulated at *each* fish-plate joint; the contact boxes are specified 20 to 50 feet apart, and the insulated sectional rail lengths are some multiple of these distances.

A large portion of this patent is devoted to very ingenious methods of automatically blocking the line so as to prevent the possibility of collisions between the trains; and with this portion of the patent I have at present nothing to do, as it in no way applies to tramways. The only reference to an electrical method of making successive connections between the long sections of the insulated rail and the main insulated conductor, is partially quoted in Prof. Ayrton's letter; but, for the information of your readers, I will give the whole quotation (of 12 lines out of a patent of 12 pages), and thus enable them to judge how far the claims put forward can be substantiated by the patent of 1881. The passage occurs on page 15, lines 7 to 17, and runs as follows :—"Instead of the mechanical plungers shown on Sheet 2" (referring only to sectional conductors a mile or more in length) "for automatically connecting the main cable with the section just entered by the train, and for automatically disconnecting the main cable from the section the train is leaving, we may use electric means for this purpose, based on the wheels, rollers or brushes on one side of a carriage, completing the electric circuit through the wheels, rollers or brushes on the other side; or based on the wheels, rollers or brushes in the front of a carriage or train being in connection with the insulated section just entered on, whilst the wheels, rollers or brushes in the rear of a carriage or train are in contact with the insulated section being left, and so connecting, for a short time, the two insulated sections electrically together, or we may employ a magnetic arrangement depending for its action, not on the weight of the train, but on its magnetic mass."

Parenthetically, I may remark that Profs. Ayrton and Perry limited themselves in the above quotation to the application of electrical means of connection to the devices, shown on Sheet 2, which have all reference to sections "a mile or more in length," and, in their patent, 2,395, 1883 (which, it should be noted, is subsequent to mine, 1,791, 1883), this limitation, for good reason, as I shall show, is persisted in.

Dr. Hopkinson took out a patent in October, 1882, No. 4,718, in which he described an electrical method of connecting a sectional rail to an insulated main con-

ductor, that method being based upon the difference of potential produced by the motor of the train acting as a generating dynamo when cut off from the main (on entering an unconnected section). This method Profs. Ayrton and Perry, in their 1883 patent, claim as being that which they intended to describe in the quotation which I have already given you from their patent of 1881; this is what they say (2,395, 1883, page 21, lines 8 to 11):—"His" (Dr. Hopkinson's) "method of actuating the box is that previously suggested by us in our original patent, 783, 1881, page 15, lines 12 to 16, and used by us in the method illustrated in fig. 20 of this specification."

A reference to lines 12 to 16, on page 15 of the 1881 patent, quoted above, will show those of your readers, who may not already be aware of the fact, how prone Prof. Ayrton is to read his knowledge of the present into his hints of the past.

To return to the 1883 patent; in it electrical methods of connecting the sectional rubbed rail to the main conductor are shown, the methods of connection depending on a short circuiting of the main current as the train passes from one section of the rubbed sectional insulated rail to another. That such a plan could be worked I have no doubt, but it is evident that it could only be applied in cases (as the inventors themselves specify) where the sections are a mile or more in length, as it is only under such conditions that the contact boxes could be subject to the supervision which they would evidently require on account of the heavy spark which must result in them as a consequence of breaking such short circuit. The patentees were evidently aware of this objection, for they propose to reduce it by introducing a double winding to their magnets, one of which shall be of high resistance; the remedy, however, is as bad as the disease, as the self-induction of the high resistance coil would yield a spark quite as hurtful as the one it is intended to avoid.

I do not claim for my system absolute immunity from sparking, but the small spark which can occur, *is not in the closed contact box*, but at the end of the sectional surface road-bar which is built to withstand hard usage, whether electrical or mechanical. This is effected by the plan of electrically charging each section in advance of the one actually rubbed by the car contact.

Professor Ayrton is evidently so well acquainted with the various patents which have been granted to me for the application of electricity to tramway working that he will not be surprised to find that in my patent, No. 1791, of April, 1883, page 2, lines 12 to 30, I specified the use of secondary batteries carried by the tramcar to influence through a magnet, also carried by the car, a carrier or contact maker between the insulated conductor and the sectional conductor, thus anticipating his patent of 1883 by a few months.

Frank Wynne.

March 11*th*, 1890.

I have read with interest your recent notices of sectional conductors for tramways, but I think that one claim for the superiority of this over other systems does not hold good, viz., that of its "being an absolute safeguard against the possibility of including the ordinary traffic of the street," for we are told there are always two sections, and for a short space of time, at intervals, three sections connected with the insulated main; thus there must always be a portion of these sections extending before and behind the car. Now, everyone knows that it is hardly possible for a tram to travel even a short distance in a busy thoroughfare without being closely followed by some conveyance; then, again, at cross streets we have horses continually crossing close behind the cars. In view of these facts it would be surprising if cases were not continually occurring of horses receiving the full effect of the P.D. of 200 volts.

Yet, again, in wet weather the rubbing sections, which are only separated by a short space, would be in actual electrical connection with each other, and as only the resistance between the sections comes into the question, it is apparent to what a great distance the shocking effect would extend. I am inclined to consider, after taking these points into account, that, far from being the safest system, it is the most dangerous—and *really* dangerous—for even with so low a pressure as 200 volts cases have occurred of horses being killed outright by a shock.

If the sections are made in short lengths, say half of the length of the car, or, for perfect security in dry weather, one-third of the length, the difficulty is partially obviated; but how would it be in wet weather?

I should like to witness the effect upon a horse of its obtaining a "*good foothold*" upon a *live* section of Mr. Wynne's crenellated contact plate, and at the same time stepping upon one of the rails.

Walter P. Adams, A.I.E.E.

Charlton, Kent, *March* 10*th*, 1890.

Far Distance Dynamo.

Referring to the letter of Messrs. Bolling and Lowe in your issue of 28th ult., I fail to see the advantage of the arrangement described, and should be much obliged for an explanation thereof.

If I understand the description, G is a compound-wound dynamo maintaining constant potential at its terminals, and F D is a small series-wound machine, whose E.M.F. varies as the current passing through it.

Such an arrangement clearly may be made to maintain constant E.M.F. at a given distance down the mains. What I cannot make out is why the series coils on the F.Ms. of F D would not produce the same effect if applied to G instead of F D. In other words, why will not a slightly under-compounded dynamo answer every purpose of the two dynamos shown, and at a smaller cost of construction?

Unity is Strength.

Liverpool, *March* 10*th*, 1890.

Harmonising Insurance and Electric Light Risks.

In your last issue you print as above the title only of a report laid before the National Electric Light Association meeting at Kansas City, but without waiting for the report itself, which it is much to be hoped will form one of those to which you will "return in due course," its title, when taken in conjunction with general experience on this side of the water, and more especially the letter of "Remonstrance" in your issue of January 17th last, is a text upon which a lengthy sermon might be based.

Without wishing to occupy your valuable space beyond the bounds of reason, it would possibly be of advantage if I were permitted to fill some small portion of it with a consideration of the present position of the two interests in the United Kingdom, and more especially in London.

That electric lighting has made in the past, is making, and will make vast advances, is without doubt due to its great superiority in every way to the older illuminants, and not the least of its claims is that of increased safety from fire risk; but that its success has been gained in the teeth of the severest opposition of some of the fire insurance companies is equally true, an opposition none the less marked because disguised beneath expressed favour.

Fortunately for both lighting contractor and consumer the fight has hitherto been almost exclusively confined to the metropolis, and slowly but surely the tide of common sense is rising to overwhelm the most factious of the opponents of electric lighting, but as, though probably sure, the tide is certainly slow, help to break down the barriers which stop its progress should be gladly welcomed, and no aid can be so

efficacious as the publication of any and every instance of ignorance or vexatious interference on the part of that most extraordinary individual, the average fire office inspector.

When the first of this race appeared, his advent was greeted with delight by every straightforward electrical engineer; he was a novice, to be sure, and gave a lot of trouble to teach him the first rudiments of the science some of us had practised for years before his coming on the scene. Still electrical engineers, being a hopeful race, quick to recognise latent possibilities, bore with his youthful indiscretions and trusted that when he had gained a little of the ballast of experience, sowed his wild oats, an esteemed and honoured co-worker might be the result—some of his brothers have indeed done well—but taken as a whole the string have not proved a credit to their trainers.

Long before our typical inspector could lay claim to more than the merest smattering of electrical knowledge, he thought himself competent to instruct his teachers, and took to comic literature in the form of rules with a big R, which he altered at frequent intervals. And not so foolish either, for a continual alteration of rules served as a peg on which he could hang quasi-learned discourses on the advance of electrical science.

But nothing short of continually bringing his shortcomings before the public will apparently force him to give up his bad habits and reform his ways.

"Remonstrance" did not in the least overstate the absurdity of many of the so-called inspections, and as far as my own experience has gone, I find that a policy of masterly inactivity is by far the best way of getting over the difficulties raised by such a man; do nothing, and the chances are that on his next visit he will compliment you on the very point he condemned before.

There will ultimately be a better state of things inaugurated. Fire insurance companies blessed (?) with such officials will find that their common-sense rivals are getting the business their own inspectors are driving away from the doors, the public will become properly informed of the real safety of electric lighting, and insist that duly-qualified men, with electrical knowledge, free from fads, and not possessing axes to grind, shall inspect; and, above all, they will learn that good firms, with a reputation to lose, may be trusted to do good work for their own reputation's sake, and subject, by all means, to competent inspection, knowing as they do that fifty successful installations will not blot out the effects of one failure.

There was a time when people thought that gas went through the pipes a flaming fire, and touched them to see if they were hot; but all that has past and gone, and so the present differences between the insurance and electric light interests will pass away by the triumph of common sense over fad.

But why need this time be delayed? Why cannot the representatives of both sides talk it over in a friendly manner, lay their respective views before practical consulting electrical engineers unconnected with systems, and settle by mutual concession on some line of conduct, which, whilst conducing to their own interests, will also remove the present state of scare from the minds of the public, and substituting skilled inspection for that which at present prevails, remove the restrictions under which electric lighting labours, and bring within the means of everybody that which at present is a luxury for the rich alone.

My long connection with some of the foremost electrical firms allows me to speak with some authority, although, whilst enclosing my card, I can, for obvious reasons, only sign myself

A Contractor's Engineer.

Dynamo Designing.

Your remark on page 223, that such points as come into the practical designing of dynamos are not referred to in professional lectures, is hardly just. Of course, I cannot speak for other institutions or other lecturers; but I may certainly claim that such points as the current capacity of armatures and the demagnetising effect of the armature current, are not neglected in the lectures at the Finsbury Technical College. In evidence of this, I beg to enclose one of last year's examination papers, which, should your space permit, you are welcome to print *in extenso*. And I may add that in my special course of lectures on dynamos during the present winter both these neglected topics received very full and careful consideration.

Silvanus P. Thompson.

March 10th, 1890.

[The following are the questions, five only to be attempted, enclosed in Prof. Thompson's letter; upon this we shall probably have something to say in due course.—EDS. ELEC. REV.]

1. An electro-magnet consists of two parallel limbs of wrought iron, each 10 centimetres long, and one centimetre square in section; they are two centimetres apart, and joined by a yoke of same stuff. The armature is a similar bar, four centimetres long. Assuming the formula, P (grammes) = B 2 A/8 π g, calculate the number of ampère-turns requisite to make the force of attraction between the electro-magnet and its keeper 30 kilogrammes.
(N.B.—Use Hopkinson's curve for relation between B, H, and μ.) [20 marks.]

2. In the above electromagnet, calculate approximately the coefficient of leakage of magnetic lines from limb to limb, with magnetising forces of 100 ampére-turns and of 2,500 ampère-turns respectively: (*a*) when the armature is absent; (*b*) when the armature is one millimetre away; (*c*) when the armature is two millimetres away from the poles. [25 marks.]

3. The sketch given you represents a dynamo, drum wound, with 72 conductors around the armature, to yield 400 ampères at a potential of 50 volts, when running at 800 revs. per minute. Assume that in the armature the insulation between the core-disks occupies $\frac{1}{17}$ of the volume. Take the values of B, H, and μ from Hopkinson's curve. Assume that the resistance of the armature is 0·006 ohm. Calculate the degree to which the armature core must be magnetised to give the required output. Also calculate, after making adequate assumptions (or calculations) about magnetic leakage, the number of ampère-turns required upon the field-magnet to produce this excitation when there is no demagnetising action going on in the armature. [20 marks.]

4. Assuming that at full load the brushes of the above dynamo must be advanced until they come just opposite the corners of the polar surfaces, calculate the demagnetising effect of the armature current; and from this and the lost volts in the armature calculate the number of turns of wire that must be wound, in series, on the field magnets in order to "compound" the machine. [20 marks.]

5. Sketch a suitable commutator for the above dynamo, showing dimensions of parts, and giving notes about materials suitable for the various parts. [20 marks.]

6. Design a pulley of suitable dimensions for running the above machine; belt speed not to exceed 2,500 feet per minute. [15 marks.]

7. Discuss the various forces to which the armature wires of dynamos and motors are subjected, and the methods adopted for securing them, and for transmitting the power to them from the shaft, or *vice-versâ*. [20 marks.]

8. How would you test the efficiency of an alternate current dynamo? What apparatus is necessary, and how would you deduce results from observations? [20 marks.]

Vacuum Illumination without Electrodes.

The interesting experiment described by Mr. James Moser in last week's issue reminds me of a phenomenon observed by some men whose duty it was to attend to the 2,000 volt mains in an electric lighting centre, and where a vacuum tube was employed as a test for the insulations. The first observation was related as follows: "On laying the vacuum tube on the ground near the cables it gave out a beautiful light, although there was no contact with the terminals of the tube. This has been several times observed, and with tubes without terminals, although, for some reason, it is not regularly produced. It would appear that the air in the vicinity of the cables, under certain conditions, becomes affected in the same way as Mr. Moser's outer tube when containing air, and this condition the vacuum is capable of detecting without metallic terminals.

James C. Richardson.

March 11th, 1890.